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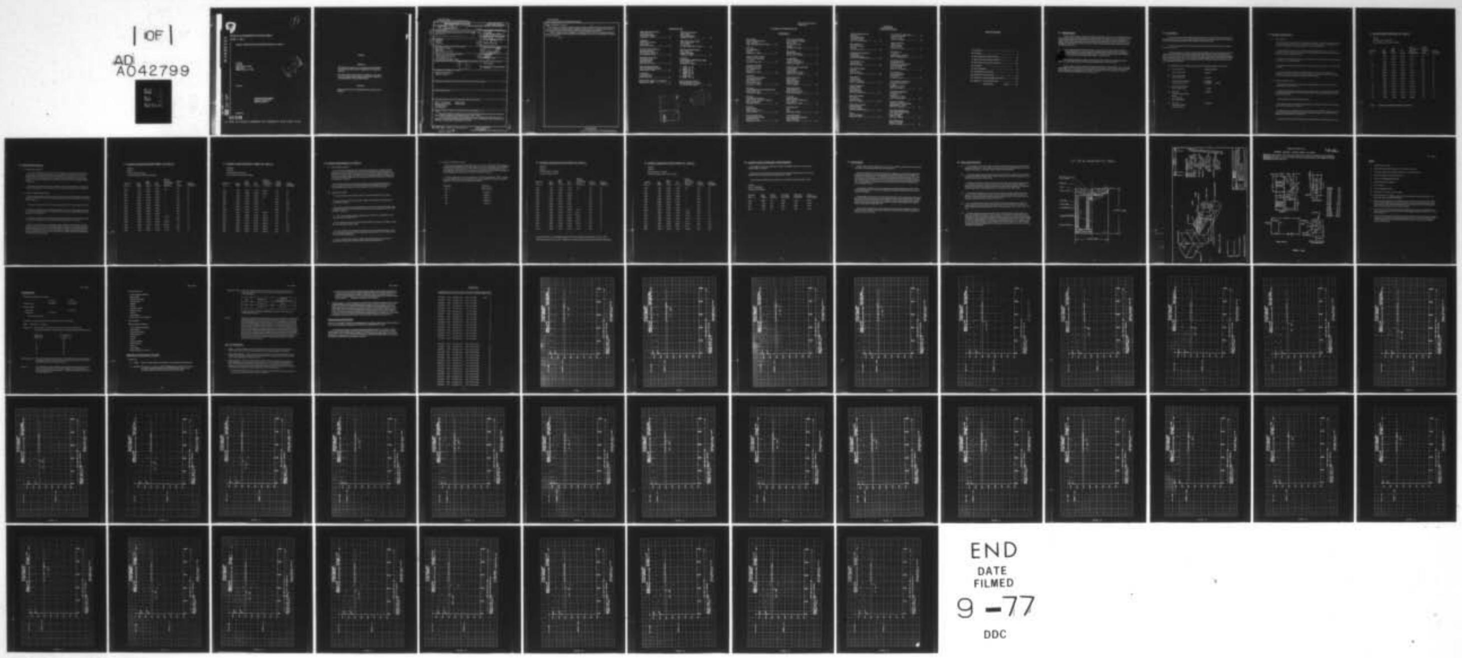

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Research and Development Technical Report

ECOM - 72 - 0288 - F

PRIMARY LITHIUM ORGANIC ELECTROLYTE BATTERY BA - 5598 ( )/U

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June 1977

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1. REPORT NUMBER 18 19 ECOM - 72 - 0288 - F	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) 6 PRIMARY LITHIUM ORGANIC ELECTROLYTE BATTERY BA - 5598 ( )/U.		5. TYPE OF REPORT & PERIOD COVERED 9 Final Report, 1 December 1972 - April 1976.
		6. PERFORMING ORG. REPORT NUMBER ECOM - 0288-F
7. AUTHOR(s) 10 S. Kravetz N. Raman		8. CONTRACT OR GRANT NUMBER(s) 15 DAAB07-72C-0288 new
9. PERFORMING ORGANIZATION NAME AND ADDRESS Mallory Battery Company 60 Elm Street ~~North~~ Tarrytown, NY 10591		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 16 17 1L763702DG10 01 - 213
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Electronics Command ATTN: DRSEL - TL - PD Fort Monmouth, New Jersey 07703		12. REPORT DATE 11 June 1977
		13. NUMBER OF PAGES 57
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) 12 59p.		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Primary Lithium Organic Electrolyte Battery, Sulfur Dioxide Electrolyte
Low Temperature
Lithium Anode
Carbon Cathode

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report summarizes the program which was aimed at developing a Primary Lithium Organic Electrolyte Battery capable of operating over a temperature range of -40°F. to 125°F.

A 15.0 volt battery was designed with hermetically sealed cells to withstand high temperature storage conditions and to operate simulated field equipment pulse loads. The cells are designed for energy densities up to 150 WH/LB at room temperatures at approximately 0.4A drains.

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Item 20. ABSTRACT - Continued

The contract was modified to incorporate a new hermetically sealed cell to replace the original compression sealed cell. In addition to preventing leakage of SO_2 during storage at 160°F., the cell design self venting mechanism enhanced the safety characteristics associated with Lithium Organic Primary Batteries.

The battery nomenclature and configuration was modified in order to meet the Technical Requirements of the BA - 5598 ( )/U Battery, which was reduced in size and weight to as much as 50% as compared to the original BA - 584 ( )/U Battery.

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2.0 INTRODUCTION

The BA - 584 ( )/U Battery consisted of ten compression sealed cells, connected as two parallel stacks of five cells each. After fabrication of the cells and batteries, there was slight visual evidence of electrolyte leakage during two months ambient storage. These leakers could not be reliably removed. This resulted in inconsistent and reduced capacity, as well as encountering difficulty in meeting the initial voltage delay time required, when subjected to initial discharge. This was attributed to the loss of the sulfur dioxide electrolyte through the rubber septum seal area and the soldered vent disc area.

It was mutually agreed by the Contractor and the Government that the problem could be eliminated by the incorporation of design features recently developed for the Mallory Battery Company by the " P. R. Mallory Laboratory for Physical Science" in Burlington, Mass. These features, developed under programs funded by Mallory included the glass to metal hermetic seal and the highly reliable " convolution vent ".

It was further agreed that the LO25S size cell could be used and that the battery configuration could be reduced in size and weight with new specifications and identified as the BA - 5598 ( )/U Battery.

The BA - 5598 ( )/U Battery consists of five LO25S cells connected in series rated at 15.0 volts nominal open circuit voltage. The LO 25S cell is rated at the same capacity as the LO26E cell, but the 5 cell BA - 5598 ( )/U battery will have fifty percent of the capacity of the 10 cell BA - 584 ( )/U Battery. The loss in capacity was sacrificed in favor of a more compact and lighter battery to be used in the field.

3.0 CELL DESIGN

In the new hermetic sealed cell (LO25S), the positive electrode cell contact is made with a tantalum tube and insulated from the top metal cover by a glass bead. The tantalum tube is internally connected to the cathode by means of a welded tab. The top assembly is TIG welded to the outer can and sealed.

Venting is accomplished by virtue of a propietary design, whereby the venting mechanism is an integral feature of the cell case.

The LO25S cylindrical cell is rated at 10 AH, at ambient temperature and uses the LI/SO_2 electrochemical system, consisting of a lithium anode, a carbon cathode and an organic electrolyte composed of liquefied SO_2, a lithium salt and an organic solvent. The SO_2 is the depolarizer. Initially the cell has an internal pressure of approximately 3.5 atmospheres at 25°C. The cell is constructed by winding rectangular widths of anode separarators, cathode separator layers of appropriate widths into a cylindrical composite roll. The lithium anode is connected internally to the nickel plated steel container.

The LO-25S cell consists of the following components with approximate dimensions and weights:

A)	Anode, Lithium Foil	Approximate WGTS.	
	1.35" X .012" X 28.5"	4.0 grams	
B)	Cathode, 95% Carbon 1.35" X .033" X 26"	5.75 grams	
	Conductor Aluminum Exmet	2.75 grams	
	5 Al, 10 3/0 26" X 1.35"	8.5 grams	TOTAL
C)	Separator (Polypropolene) .001" X 1.625" X 62"	.8 grams	
D)	Electrolyte 70% concentration of sulfur dioxide 23% Acetonitrile 6% Lithium Bromide	35.5 grams	
E)	Can & Top Nickel plated CRS can Glass to Metal Top	41.5 grams	

4.0 BATTERY PERFORMANCE

4.1 Design Test Phase

The first group of sixteen BA - 5598 ( )/U Batteries were subjected to the thirty day storage requirement of 160°F., then given a mechanical shock and vibration test. Four (4) randomly selected batteries were subjected to an additional waterproofing of jacket test, prior to the discharge test.

The batteries were tested for open circuit voltage and examined visually. There was no evidence of any significant change in open circuit voltage from the original readings. The jacket visual examination did not show any evidence of bulging or stains.

The batteries were divided into four groups of four batteries each and pre-conditioned for a minimum of eight hours prior to the actual discharge.

The discharge test specified that four batteries each would be tested for capacity at 75°F, 125°F,- 20°F and - 40°F.

The A2 unit would be discharged through a load resistance of 14.2 ohms for two minutes, then through a load resistance of 291.0 ohms for eighteen minutes and cycled continuously to an end voltage of 10.0 volts. The actual performance of each battery is shown in table 1.

4.2 Summary of Design Test Phase

The batteries did not perform as expected at the - 20°F temperature, giving only 50% to 85% of the required capacity of thirty (30) hours.

Examination of the batteries localized the reason for capacity failures to the glass bead used. The underside of the glass bead was observed to have a conductive coating which was measured between 100 ohms and 1000 ohms resistance.

A high percentage of this coating was analyzed as iron.

This initial production run was caused by utilizing a welder with insufficient capacity to join the bead washer to the top, resulting in cracked glass.

To expedite the use of existing parts, the glass was remelted in a high (1000°C.) temperature oven. The reflowing of the glass apparently had resulted in some unknown phenomena to be introduced that was subsequently attacked by the SO_2 within the cell.

Corrective action was taken on the subsequent lots of tops whereby reworked glass would not be used.

4.3 BATTERY DESIGN TEST PHASE - BA - 5598 ( )/U

TABLE I

Discharge Capacity Test Results

Stored 30 Days at 160^{0}F. Before Discharge

BATTERY NO.	TEST TEMP.	TEST TEMP. O. C. V.	70^{0}F. O. C. V.	INITIAL VOLT DELAY TIME TO REACH 10.0V.	HOURS TO END VOLTAGE (10.0)	HOURS REQUIRED
1	75^{0}F.	14.847	14.846	0.0 ms	64.0	45
4	75^{0}F.	14.635	14.729	0.0 ms	59.5	45
9	75^{0}F.	14.672	14.680	2.1 sec	60.0	45
18*	75^{0}F.	14.506	14.517	5.0 ms	60.5	45
2 *	125^{0}F.	5.72	14.375	Fail	None	45
5	125^{0}F.	14.761	14.825	0.0 ms	49.5	45
8	125^{0}F.	14.633	14.764	0.0 ms	51.5	45
14	125^{0}F.	14.837	14.872	0.0 ms	61.0	45
3	- 20^{0}F.	14.892	15.002	1.7 sec	20.5	30
	- 20^{0}F.	14.773	14.692	14.0 min	17.0	30
12*	- 20^{0}F.	14.339	14.551	8.0 min	25.0	30
15	- 20^{0}F.	14.682	14.510	12.0 min	15.5	30
7 *	- 40^{0}F.	14.538	14.616	4.0 min	17.8	15
10	- 40^{0}F.	14.855	14.764	16.0 min	18.0	15
11	- 40^{0}F.	14.919	15.000	2.0 min	18.0	15
13	- 40^{0}F.	14.740	14.435	18.0 min	14.5	15

NOTE: (*) DENOTES BATTERIES SUBJECTED TO WOJ TEST.

5.0 BATTERY PERFORMANCE

5.1 Fabrication Phase Number 1

A lot of one hundred fifty seven (157) BA - 5598 ( )/U Batteries was then fabricated using hermetic seal tops made with virgin glass material. Thirty Two (32) randomly selected batteries were used as samples to be tested as specified. The batteries were divided into two groups of sixteen each. Group I was subjected to environmental tests, then discharged. Group II was subjected to a Ten day storage period in an environment of 160^{0}F., then to the shock and vibration tests before being subjected to the discharge test.

The discharge test specified was the same as stated for the Design Test Phase Batteries. The actual performance of each battery is shown in Table II for Group I batteries and Table III for Group II batteries.

5.2 Summary of Fabrication Phase Number 1

There was significant improvement in the battery performance at the -20^{0}F. temperature, although two batteries of Group I failed to meet the minimum requirement of 30 hours, completing 28.6 hours and 29.6 hours respectively.

One battery in Group II failed to meet the minimum requirement of 27.0 hours completing 24.6 hours.

There was no significant difference in battery performance at 75^{0}F. and 125^{0}F. of batteries stored 10 days at 160^{0}F. versus batteries having no storage at 160^{0}F., where all batteries discharged in both groups exceeded the 45 hour minimum.

The difference of hours at the -20^{0}F. discharge temperature may be related to the inconsistent storage period of cathode assemblies prior to sealing of cells. This phenomena has not been verified.

However, the introduction of a low temperature electrolyte filling and sealing technique, during the cell process, may have contributed to encouraging atomspheric moisture to the cell, which was shown to affect capacity performance. The operation is under complete investigation to develop more uniform and consistent manufacturing techniques. A more reliable temporary sealing technique was introduced subsequently to eliminate the tendency of having a nebulous seal. In addition, the time delay was shortened to complete the tube seal by welding.

5.3 BATTERY FABRICATION PHASE NUMBER 1 BA - 5598 ( )/U

TABLE II

GROUP I

Discharge Capacity Test Results

No Previous Storage at 160^{0}F. Before Discharge

BATTERY NO.	TEST TEMP.	TEST TEMP. O. C. V.	75^{0}F. O. C. V.	INITIAL VOLTAGE DELAY TIME TO 10.OV.	HOURS TO 10.OV.	HOURS REQUIRED
0006	75^{0}F.	14.806	14.826	Inst.	73.0	50
0014	75^{0}F.	14.798	14.819	"	74.0	50
0022	75^{0}F.	14.801	14.819	"	70.6	50
0030	75^{0}F.	14.798	14.820	"	70.3	50
0002	125^{0}F.	14.792	14.783	"	70.3	45
0010	125^{0}F.	14.799	14.813	"	66.0	45
0018	125^{0}F.	14.792	14.800	"	68.6	45
0026	125^{0}F.	14.803	14.831	"	69.6	45
0008	- 20^{0}F.	14.804	15.063	"	28.6	30
0016	- 20^{0}F.	14.763	14.993	"	32.3	30
0024	- 20^{0}F.	14.803	15.070	2.5 sec	34.0	30
0032	- 20^{0}F.	14.796	15.058	1.2 sec	29.6	30
0004	- 40^{0}F.	14.792	15.096	12.0 sec	21.6	15
0012	- 40^{0}F.	14.796	15.083	30.0 sec	19.6	15
0020	- 40^{0}F.	14.804	15.123	15.0 sec	22.3	15
0028	- 40^{0}F.	14.799	15.129	6.0 sec	24.0	15

5.4 BATTERY FABRICATION PHASE NUMBER 1 BA - 5598 ( )/U

TABLE III

GROUP II

Discharge Capacity Test Results

Stored 10 Days at 160°F. Before Discharge

BATTERY NO.	TEST TEMP.	TEST TEMP. O.C. V.	70°F. O. C. V.	INITIAL VOLTAGE DELAY TIME 10.0V	HOURS TO 10.0 VOLTS	HOURS REQUIRED
0005	75°F.	14.955	14.752	500 ms	72.6	45
0013	75°F.	14.936	14.888	500 ms	71.3	45
0021	75°F.	14.960	14.882	Inst.	71.3	45
0029	75°F.	14.992	14.910	"	69.6	45
0001	125°F.	14.951	14.705	"	69.0	40.5
0008	125°F.	14.929	14.861	"	66.0	40.5
0017	125°F.	14.952	14.878	"	67.6	40.5
0025	125°F.	14.972	14.793	"	68.3	40.5
0007	- 20°F.	14.927	14.774	500 ms+	29.6	27
0015	- 20°F.	14.982	15.103	50 sec	24.6	27
0023	- 20°F.	14.998	15.189	500 ms+	34.0	27
0031	- 20°F.	14.971	15.178	500 ms+	30.3	27
0003	- 40°F.	14.964	14.836	500 ms+	27.3	13.5
0011	- 40°F.	14.879	15.066	500 ms+	21.0	13.5
0019	- 40°F.	14.918	15.134	500 ms+	28.0	13.5
0027	- 40°F.	14.956	15.174	500 ms+	25.6	13.5

6.0 BATTERY PERFORMANCE - BA - 5598 ( )/U

6.1 Fabrication Phase Number 2

A second lot of one hundred fifty seven (157) batteries was fabricated of which thirty two (32) samples were randomly selected from the lot for tests as specified. The thirty two (32) samples were divided into two groups of sixteen (16) batteries each. Group I required no additional storage, but was subjected to the mechanical shock and vibration tests prior to discharge as specified. Group II required thrity (30) days storage at 160^{0}F. prior to the same mechanical shock and vibration tests, followed by the discharge tests as specified.

Both groups of batteries were pre-conditioned at there respective discharge temperatures for a minimum of eight hours, then the A2 section was subjected to the pulse loads of 14.2 ohms for 2 minutes and 290 ohms for 18 minutes, cycled continuously to the 10.OV test end voltage.

6.2 Summary of Test Results

The capacity data of Group I are listed in Table IV. Group II capacity data is listed in Table V.

The Group I batteries, without previous 160^{0}F. storage met the required hours of capacity at the four temperatures specified.

The secondary requirement of "Initial Voltage Delay" which is the time required at the beginning of discharge for the battery to reach 10.OV and not exceed 0.5 seconds, was achieved at the 75^{0}F., 125^{0}F., and - 20^{0}F. temperatures.

At - 40^{0}F., the initial voltage delay time ranged from nine (9) seconds to one hundred and eleven (111) seconds before reaching 10.0 volts.

The Group II batteries which were stored for 30 days at 160^{0}F. were required to be capable of having 90% of the initial capacity without storage.

Due to the limitation of the discharging of four batteries each at the specified temperatures, it could not be statistically verified that there was any change in total capacity hours, from the initial discharge versus the storage discharge groups.

It is safe to assume that after 30 days of 160^{0}F. storage that the batteries would not show any appreciable loss in capacity due to the high reliability of the hermetic seal design.

6.2 Summary of Test Results continued....

The Group II, high temperature storage batteries which were tested at - 20^{0}F. and - 40^{0}F. temperatures, exceeded the 0.5 seconds required as the initial voltage delay time was recorded between 2.15 seconds and 5.15 seconds before reaching 10.0 volts. At the - 20^{0}F. temperature, the initial voltage delay time was recorded between 2.15 seconds and 5.15 seconds before reaching 10.0 volts. At the - 40^{0}F. temperature, the initial voltage delay time was recorded between 1.56 seconds and 15.6 seconds.

The initial voltage delay time at the low temperatures of - 20^{0}F. and specifically at - 40^{0}F. is increased due to the electrical conductance of the electrolyte, which decreases gradually as a function of operating temperature. This is shown in the following table for electrolyte:

Temperature (C)	Conductance (ohms - 1 cm -1)
70C.	7.45X10 - 2
50C.	6.80X10 - 2
20C.	6.02X10 - 2
0C.	5.05X10 - 2
-30C.	3.67X10 - 2

6.3 BATTERY FABRICATION PHASE NUMBER 2 BA - 5598 ( )/U

TABLE IV

GROUP I

Discharge Capacity Test Results

No Previous Storage at 160^{0}F.

BATTERY NO.	TEST TEMP.	TEST TEMP. O. C. V.	75^{0}F. O. C. V.	INITIAL VOLTAGE DELAY TIME TO 10.OV	HOURS TO 10. OV	HOURS REQUIRED
0040	75^{0}F.	14.926	14.918	Inst.	71.3	50
0072	75^{0}F.	14.923	14.716	"	71.3	50
0068	75^{0}F.	14.921	14.910	"	71.6	50
0085	75^{0}F.	14.964	14.960	"	71.3	50
0128	125^{0}F.	14.945	14.823	"	67.0	50
0090	125^{0}F.	14.960	14.847	"	66.0	50
0046	125^{0}F.	14.917	14.801	"	67.6	50
0034	125^{0}F.	14.929	14.830	"	68.3	50
0075	-20^{0}F.	14.944	15.208	70 ms	46.0	35
0124	-20^{0}F.	14.922	15.134	250 ms	38.6	35
0108	-20^{0}F.	14.907	15.205	100 ms	37.6	35
0091	-20^{0}F.	14.941	15.203	60 ms	40.6	35
0140	-40^{0}F.	14.937	15.230	111 sec	29.3	15
0054	-40^{0}F.	14.935	15.132	23 sec	36.0	15
0114	-40^{0}F.	14.905	15.189	9 sec	32.6	15
0063	-40^{0}F.	14.921	15.188	14 sec	34.3	15

NOTE: BATTERY NO. 0140 REQUIRED EXCESSIVE TIME (111 SECONDS) TO REACH 10.0 VOLT AT - 40^{0}F. AND RAN 29.3 HOURS TO 10.0 VOLTS. THERE WAS NO ASSIGNEABLE CAUSE FOR THE READINGS OBTAINED.

6.4 BATTERY FABRICATION PHASE NUMBER 2 BA - 5598 ( )/U

TABLE V

GROUP II

Discharge Capacity Test Results

Thirty Day Storage at 160^0F. Before Discharge

BATTERY NO.	TEST TEMP.	TEST TEMP. O. C. V.	75^0F. O. C. V.	INITIAL VOLTAGE DELAY TIME TO 10.0V	HOURS TO 10.0V	HOURS REQUIRED
0039	75^0F.	14.951	14.945	Inst.	72.0	45
0121	75^0F.	14.949	14.946	"	73.0	45
0066	75^0F.	14.952	14.948	"	71.3	45
0058	75^0F.	14.970	14.966	"	72.3	45
0120	125^0F.	14.979	14.947	"	65.6	45
0079	125^0F.	14.942	14.930	"	67.0	45
0047	125^0F.	14.924	14.930	"	67.6	45
0059	125^0F.	14.980	14.954	"	67.6	45
0086	-20^0F.	14.947	15.080	4.75 sec	46.6	30
0111	-20^0F.	14.973	15.193	4.65 sec	39.3	30
0126	-20^0F.	14.971	15.185	5.15 sec	40.3	30
0074	-20^0F.	14.948	15.130	2.15 sec	48.0	30
0071	-40^0F.	14.960	14.717	4.8 sec	34.0	13.5
0117	-40^0F.	14.979	15.200	9.15 sec	33.6	13.5
0080	-40^0F.	14.940	15.115	15.6 sec	36.3	13.5
0051	-40^0F.	14.982	15.204	1.56 sec	34.3	13.5

6.5 BATTERY CAPACITY DISCHARGE CHARACTERISTICS

The discharge curves for each of the thirty two batteries of Fabrication Phase No, 2 are shown in the Appendix, Figure 1 through 32.

Although the battery capacity was determined when the load voltage had fallen below 10.OV., this was attributed to the two minute heavy drain of approximately 1.0 amps.

The two minute heavy drain load cycle consumed in excess of 60% of the total watt hours at 75^0F.

TABLE VI
GROUP I BATTERIES
ACCUMULATED POWER

BATTERY NO.	TEST TEMP.	HOURS TO 10.OV	WATT HRS. AT 14.2 ohm	WATT HRS. AT 290 ohm	TOTAL WATT HOURS
0046	125^0F.	67.6	79.25	42.03	121.28
0040	75^0F.	71.3	82.94	44.79	127.73
0075	-20^0F.	46.0	45.04	26.69	72.73
0054	-40^0F.	36.0	32.46	20.33	52.79

7.0 CONCLUSIONS

7.1 The BA - 5598 ( )/U Battery replacement for the BA - 584 ( )/U Battery was shown to be valid in concept and capable of satisfactory performance at the cold temperatures.

The initial voltage delay time at the cold temperatures exceeded the time of 0.5 seconds specified, when the battery was loaded after the 30 day storage period at the 160^{0}F. temperature. It is noteworthy that the electrolyte conductivity at the - 40^{0}F. temperature is approximately 33% of the value at 75^{0}F., which would contribute to the added delay time. However, the delay time is a function of internal resistance of the cell, which decreases as current flows. This is evidenced by the fact that the load voltage increases with time. It is known that as the current drain for a cell is increased initially, more time is required to reach the cut-off voltage of the cell.

As a requirement, the battery was not to be loaded after meeting the initial acceptance tests, therefore the initial voltage delay time, as recorded at the beginning of discharge, was the first time that current was drained from the battery.

During discharge, the cell reactions involve the anodic solution of Li to Li^+ and the cathodic reduction of SO_2 to form $Li_2S_2O_4$ (lithium dithionite) which precipitates within the porous carbon cathode. The lithium dithionite forms a resistance layer at the carbon cathode as a function of the electrochemistry and reaches its maximum resistance in approximately 5 days at 70^{0}F. At elevated storage temperatures, it is assumed that the resistance barrier increases with time.

Another possible explanation for the initial voltage delay phenomena may be attributed to variations of moisture in the cell, which would form lithium hydroxide on the lithium anode, resulting in high internal resistance and affects surface area.

8.0 FINAL CONFIGURATION

8.1 The final design model of the BA - 5598 ( )/U battery was fabricated in accordance with the Technical Guidelines identified as SCS - 459/12 dated 25 July 1975. Due to the information obtained from the data collected on this battery, it is necessary to make the following recommendations.

8.2 The nominal voltage of each cell has been observed to read 2.98V.±.05V. Therefore it is recommended to change the specification on page 3 of SCS - 459/12 to show the A2 unit maximum voltage to read 15.15 volts. (A2 section consists of 5 cells in series).

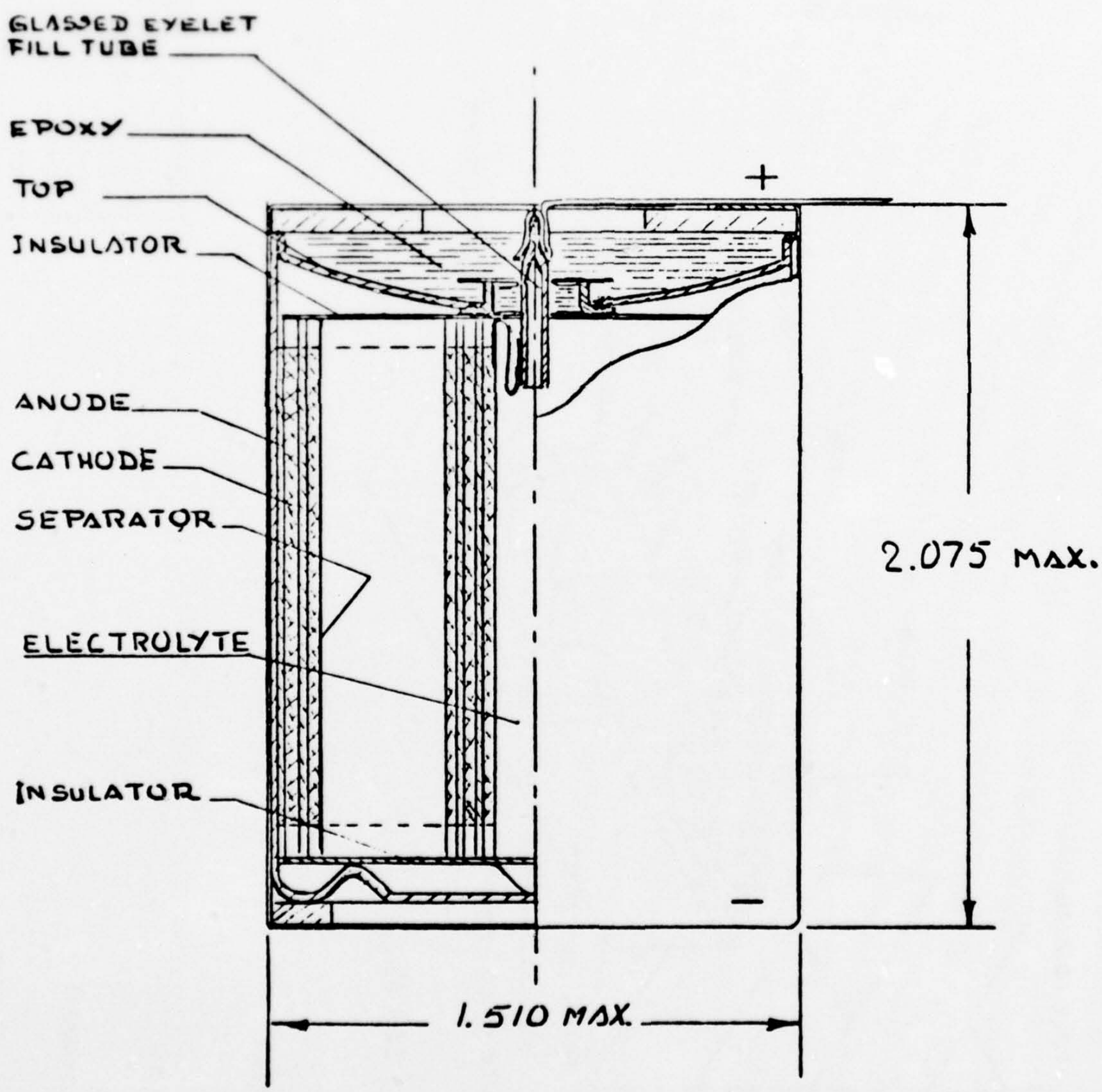
The open circuit voltage is a function of the moisture content within the cell and the variations within the specification limits of 68% to 72% electrolyte SO_2 concentrations and the ambient temperature at the time of testing. The data to establish the range of open circuit voltages was based on a 3 month period of 100% testing, of all LO - 25S cells fabricated at room temperatures from 70^{0}F. to 80^{0}F.

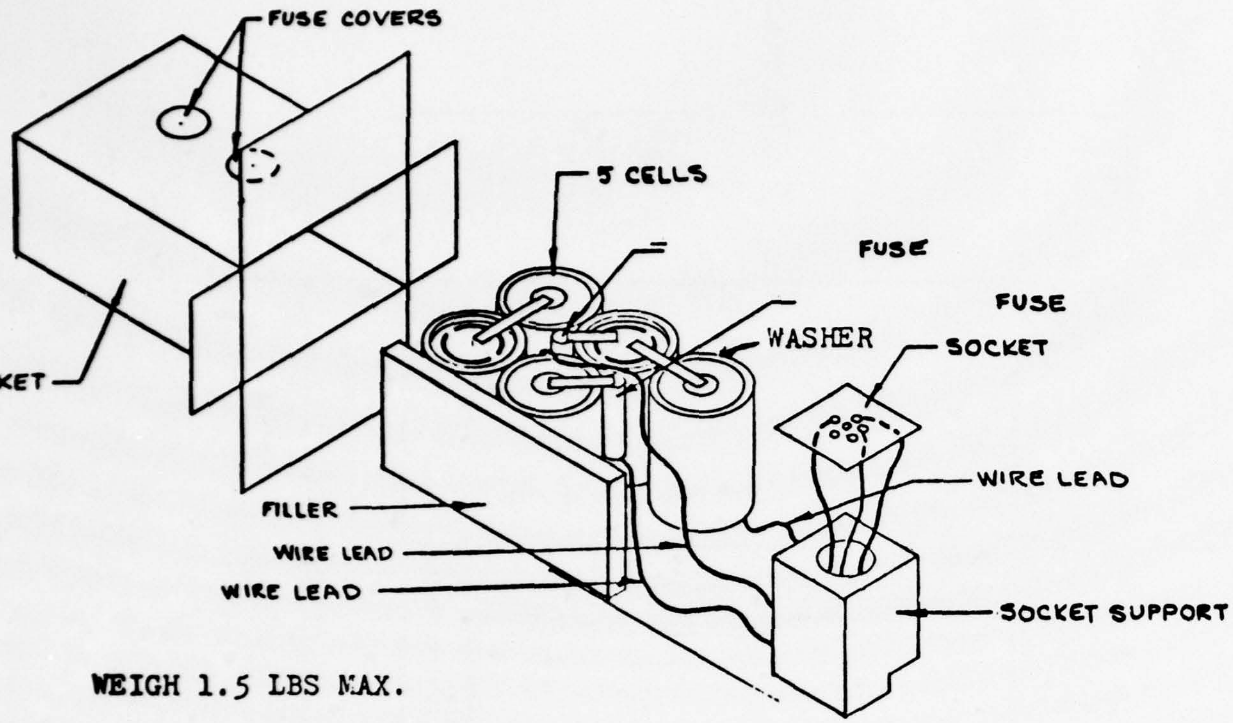
8.3 The closed circuit voltage of section A1 (A1 section consists of 1 cell) taken within 30 seconds was observed to read over 2.50 volts but less than 2.60 volts on approximately 50% of the batteries tested. Therefore, it is recommended to change the specification on page 5 of SCS - 459/12 to show the A1 unit minimum permissable closed circuit voltage to read 2.50 volts.

8.4 Due to the flexibility of the battery jacket and the basic cell design configuration, the width of the battery is slightly less than the minimum specification requirement of 3 9/16 ± 1/16 inch. Therefore, it is recommended that the specification stated on page 1 and 2 to change the width to 3 9/16 ± 1/16 - 3/32 inch.

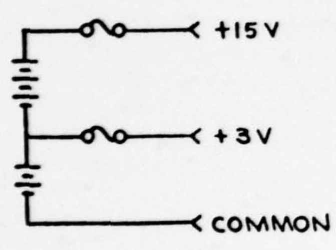
8.5 The initial voltage delay requirement on page 3 of SCS - 459/12 states that the time required at the beginning of discharge for the battery to reach a voltage of 10.0 volts after the specified load is applied, shall not be more than 0.5 seconds. This requirement implies that this time can be achieved at any temperature and after any storage period as specified. However, the data suggests after 160^{0}F. storage and discharge at - 20^{0}F. and - 40^{0}F. temperatures, that this time cannot be obtained. Therefore, it is recommended that this time requirement should apply to only discharge tests at 75^{0}F. and 125^{0}F. At the - 20^{0}F. discharge temperature, after 30 days storage at 160^{0}F., the time required to reach 10.OV was in excess of 5 seconds, yet capacity was not affected.

LO-25 S HERMETIC CELL





WEIGH 1.5 LBS MAX.



SCHEMATIC WIRING DIAGRAM

REVISIONS		
ISSUE	DESCRIPTION	MEMO

PARTS DESCRIPTION
CELL - LO-25S
FUSE - 3 AMP SLO BLO
WIRE - #20 AWG-VINYL
WASHER - .040 " FIBRE
FILLER - STYROFOAM HD 300
SOCKET SUPPORT - POLY-STYRENE FOAM
SOCKET - LAMINATED PLASTIC
NEMA NO XXXP
PER MIL SPEC PBE-
PER MIL-P-3115

CONTACT MATERIAL - SPRING TEMPERED BRASS PER QQ-B-613

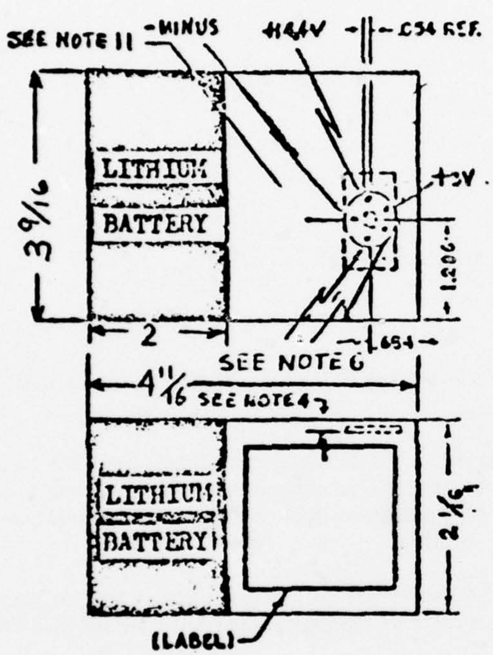
SCALE DO NOT SCALE	MALLORY — MALLORY BATTERY COMPANY		
TOLERANCES	TITLE ASSEMBLY BA5598/U, SCS 459/12		
DECIMALS	DESIGNER	DATE 10/1-75	SHEET OF SHEETS
FRACTIONS	DRAWN BY K. DORMAN		
ANGLES	CHECKED BY	B-	
	APPROVED BY		

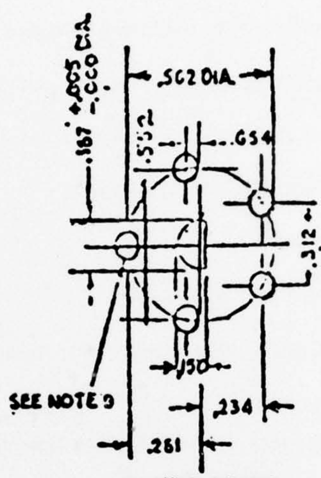
SPECIFICATION SHEET

25 July 1975
SCS-459/12

BATTERY, PRIMARY, LITHIUM ORGANIC BA-5598/U

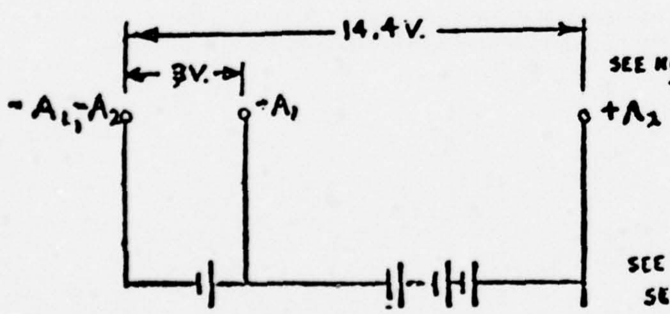
The complete requirements for procuring the lithium organic primary battery type described herein shall consist of this document and the issue in effect of Specification SCS-459.



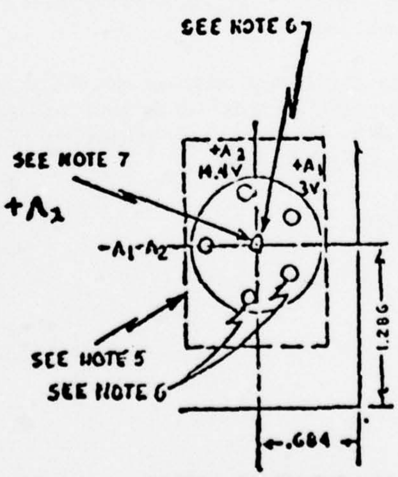


SOCKET DETAIL

INCHES	MM
0.005	0.1
0.054	1.3
0.150	3.8
0.187	4.7
0.234	5.9
0.281	7.0
0.312	7.9
0.552	14.0
0.562	14.2
0.684	17.0
1.286	32.6
2.000	50.8
2-1/16	52.3
3-9/16	90.4
4-11/16	119.0



WIRING DIAGRAM



SOCKET PLACEMENT AND VOLTAGE MARKINGS

Sheet 1 of 6

NOTES:

1. All dimensions are in inches.

2. Unless otherwise specified, all tolerances are +0.005 inch for decimals.

3. Tolerances of length, width and height of battery are ±1/16 inch for fractions.

4. The minimum depth of socket well shall be ½ inch.

5. The size of the insulating plate is optional.

6. Socket insert contact not required.

7. Pin - circle center.

8. "D" hole for plug positioning.

9. Five holes to fit 1/8 in. pins, 7/16 in. in length.

10. Socket must float $3/32\,^{+\,1/32}_{-\,1/16}$ in all directions from the specified pin circle center location in the plane of the socket from reference dimension.

11. The printed socket facsimile may be included adjacent to the socket, on the socket side of the battery, in lieu of terminal markings shown in the top view of Fig. 1. The facsimile shall be permanent, legible, include outline of socket, terminal identification shown in aforementioned top view and meet general battery marking requirements covered or referenced herein.

12. On all four (4) sides of the battery "LITHIUM BATTERY" shall be printed in ½ inch (approx.) bold lusterless green lettering (same as jacket color) on a black background extending a distance of 2.0 inches from end of battery.

13. The socket shall be supported and mounted so that the top surface of the socket shall not protrude above the adjacent outside surface of the jacket and shall not be more than 1/16 inch below adjacent outside surface of the jacket when used initially, during, and after subsequent insertions of the mating plug during contractual testing.

REQUIREMENTS:

Dimensions and Configuration: See Figure

	A_1 UNIT	A_2 UNIT
Nominal voltage:	3.0 VOLTS	14.4 VOLTS
Maximum voltages:		
Open circuit	-	15.0 VOLTS
Closed Circuit	3.0 VOLTS*	-

*Under a load of 6.76 ohms.

Terminals: Five (5) hole socket type with no obstruction of any holes (See Figure).

Weight: (maximum): 1.5 pounds.

Capacity tests: When the battery is tested in accordance with the methods of examination and tests of this specification, the minimum capacity-test requirements shall be as specified below;

Capacity Test (per SCS 459)	Service Requirement in hours
I	50
L	35
H	50
HT	45
LT	30
T	45
D	45

Initial voltage delay: When the battery is subjected to the capacity tests specified herein, the time required at the beginning of discharge for the battery to reach a voltage of 10.0 volts after the specified load is applied shall not be more than 0.5 seconds.

Drop test: When the battery is tested in accordance with this specification, the socket shall not move beyond the limits specified herein nor shall the components shift within the jacket, or preclude the battery from meeting specified " I " capacity test performed at the conclusion of the jacket integrity test.

First article inspection:

- Visual-mechanical examination
- Battery voltage
- Dimensions and weight
- Mechanical shock
- Vibration
- Altitude
- Insulation resistance
- Safety feature test
- Drop test
- Jacket integrity
- Capacity tests I, L, H, HT, and LT

Cell lot inspection:

Quality conformance inspection:

- Visual-mechanical examination
- Battery voltage
- Dimensions and weight
- Mechanical shock
- Vibration
- Altitude
- Insulation resistance
- Safaty feature test
- Drop test
- Jacket integrity
- Capacity tests HT, LT, T, and D

METHODS OF EXAMINATION AND TESTS:

Capacity tests:

(1) *Storage:* Details on storage conditions for all capacity tests are specified in basic specification.

(2) Discharge: The A_2 unit ($-A_1 - A_2$ to $+A_2$) shall be discharged through a resistance of 14.2 ohms for 2 minutes, and then through a resistance of 291.0 ohms for 18 minutes. This cycle shall be repeated continuously to a test end voltage of 10.0 volts.

Closed circuit voltage: Closed circuit voltage measurements shall be made with a direct current voltmeter of proper range and sensitivity (see basic specification), using load resistances as shown in the following table:

UNIT	RESISTANCE	MINIMUM PERMISSIBLE VOLTAGE
A_1	6.5 ohms, + 1%	2.60 volts
A_2	14.2 ohms, + 1%	12.5 volts

Voltage shall be above "MINIMUM PERMISSIBLE VOLTAGE" within thirty (30) seconds after load is applied.

Drop test: When performed during First Article Inspection, five (5) each Group III B test samples shall be subjected to this drop test just prior to performing the jacket integrity test on them. When performed during Quality Conformance Inspection, five (5) each subgroup B_2 test samples just prior to being subjected to integrity test shall have this drop test performed upon them. Each battery shall be dropped once from a height of 30 + 2 inches onto a hard surface consisting of concrete, wood or steel. The 3 9/16 inch X 2 1/16 inch side of the battery nearest the socket shall be paralled to this surface upon release, and shall make contact with it. If any failure occurs, the contractor shall take immediate action to correct the defect and eliminate the cause. However, pending this action, quality conformance acceptance shall be withheld. When the nature of the failure has been determined, and the necessary corrective action taken, the rejected lot and all batteries in process at the time of the failure shall be reworked to eliminate the defect. Reworked lots shall be reinspected using a sample size of eight (8) batteries with no failures permitted.

CELL LOT INSPECTION:

1. Cell Lot: - A cell lot is defined as those cells of a particular type which are to be used in the fabrication of a specific battery lot. Each of the cell lots shall be subjected to the inspection program outlined herein.

2. Closed-circuit Voltage Test. - All the cells in a cell lot shall be pulse tested for five (5) seconds with a 2.5 ohm resistance load. Any cell whose voltage falls below 2 volts during the 5 second pulse period shall be rejected for use in battery fabrication or further cell lot testing.

3. 160^0F. Storage Test. - From a cell lot that has been tested for closed-circuit voltage select thirty (30) cells either in random manner or at preselected intervals, whichever the Government inspector deems more desirable. The thirty (30) cells shall be stored at $160^0 \begin{smallmatrix} +3^oF. \\ -7^oF. \end{smallmatrix}$ for two (2) weeks and then at $-20^0 \pm 3^oF$. for a minimum of six (6) hours. Each cell shall be discharged through the equivalent cell load and to the equivalent cell end voltage in accordance with the initial capacity test of this specification sheet.

   a. If allthirty(30) cell samples exceed the minimum capacity service requirement by a factor of at least 10%, the lot may be used for fabrication of a single lot of batteries.

b. If there are two (2) or more failures during the capacity testing of the thirty (30) cell samples the cell lot shall be rejected. If only one (1) failure occurs, another twenty (20) cell samples shall be selected from the same lot and this same test shall be repeated. If no failures occur during retesting, the lot shall be considered acceptable. If one (1) or more cells fail during retesting, the cell lot shall be rejected and new cell lot of cells shall be submitted for cell lot inspection.

4. Cell Replenishment: - In order to replenish the twenty (20) cells consumed by the additional 160°F. storage testing, twenty-three (23) cells shall be fabricated when necessary. All shall be subjected to closed-circuit voltage test (2 above). Any cell that fails this test shall be replaced by one that has passed. Three (3) cell samples shall be selected in a random manner from the twenty-three (23) cells that have passed the closed-circuit voltage test. These three (3) cell samples shall be tested in accordance with the 160°F. storage test (3 above). No failures are permitted for acceptance of this replenishment lot of twenty (20) cells. If one or more failures occur, the lot of twenty (20) cells shall be rejected and a new lot of twenty-three (23) cells shall be fabricated and three (3) shall be tested. This procedure shall be repeated until no failures occur.

PREPARATION FOR DELIVERY:

Preservation and Packaging: Preservation and packaging shall be in accordance with latest issue of basic specification except that no intermediate packaging shall be required and unit packaging shall be as follows:

A unit package shall consist of one battery individually packaged per method 1C-1 of MIL-B-116. Battery shall be placed in a barrier bag fabricated of material conforming to L-P-378, type 1, grade B, finish 1, having a uniform thickness of 4.0 + 0.5 mils with a heat sealed closure. The bagged battery shall be placed in a close-fitting paperboard box conforming PPP - B - 636, type CF, W6c or W5c, style optional or MIL-B-43014. Closure shall be as specified in the appendix to the applicable box specification.

APPENDIX A

FABRICATION - QUALIFICATION CURVES OF SECOND TEST ONLY

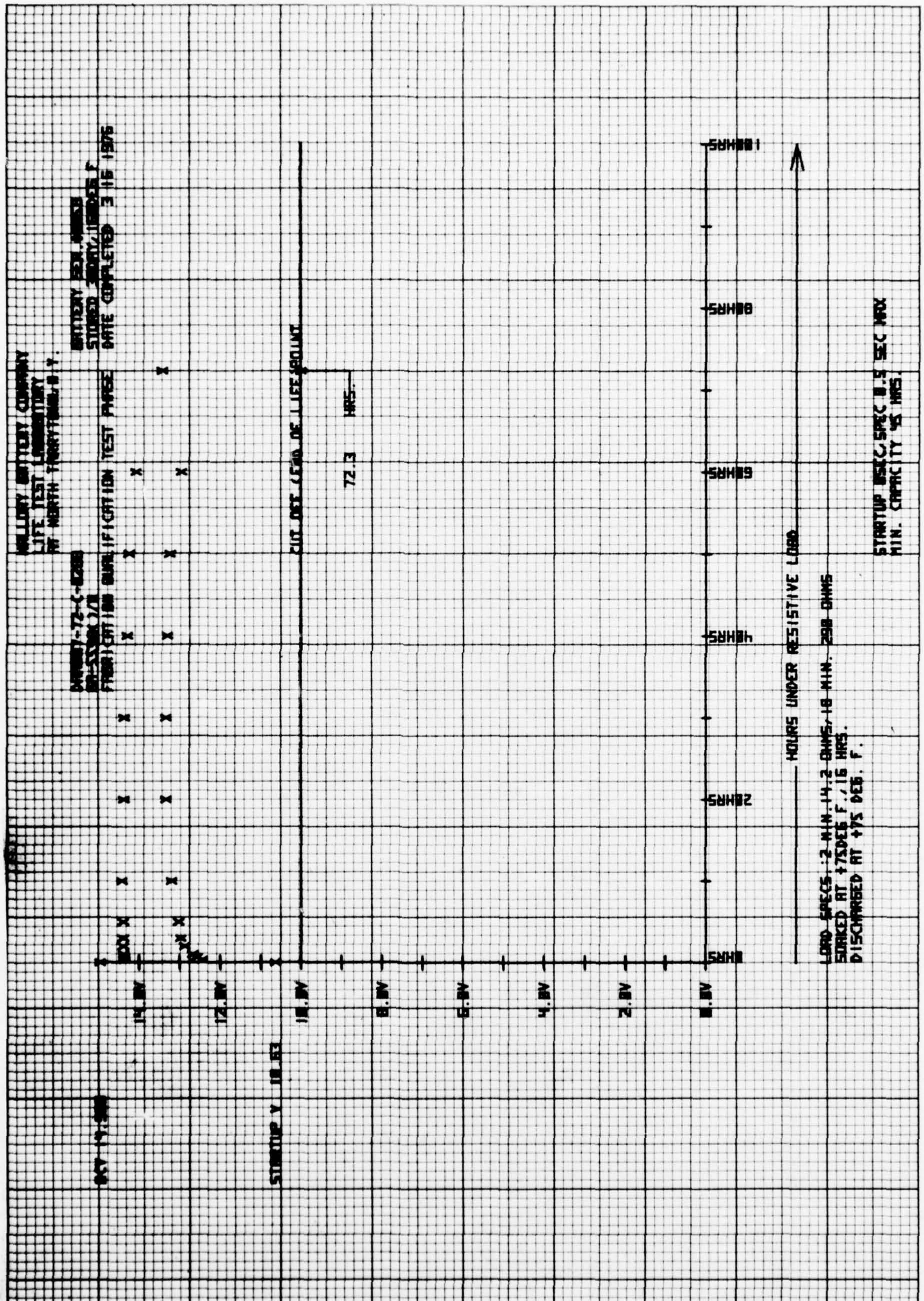

LIFE TEST LABORATORY
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
STARTUP V 10.63
CUT OFF (END OF LIFE)POINT
72.3 HRS.
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.14.2 OHMS/18 MIN. 290 OHMS
SOAKED AT +75DEG F./16 HRS.
DISCHARGED AT +75 DEG. F.
MIN. CAPACITY 45 HRS.
FABRICATION QUALIFICATION TEST PHASE
DATE COMPLETED 3 16 1976

FIGURE 1

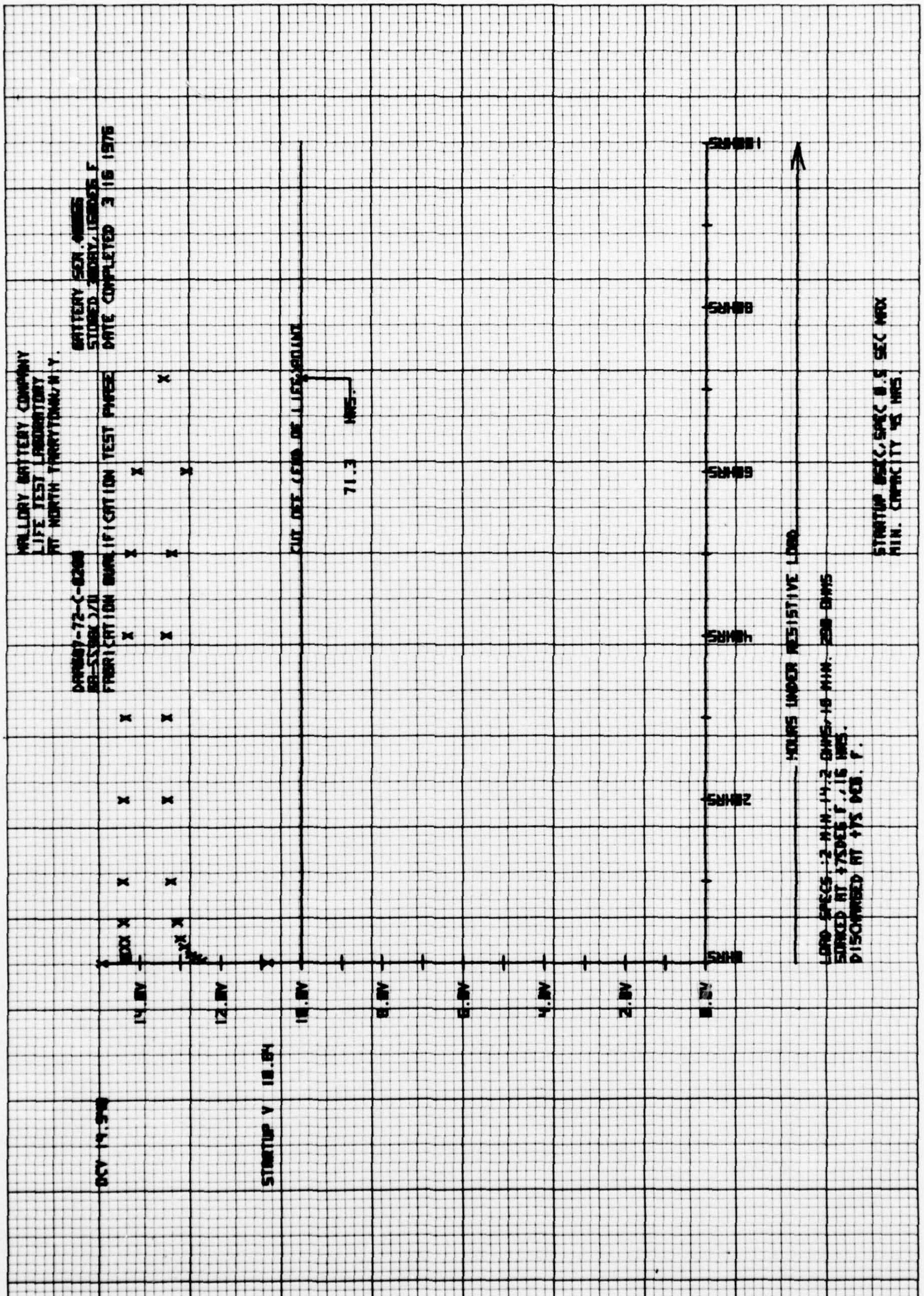

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
FABRICATION QUALIFICATION TEST PHASE
CUT OFF (END OF LIFE)POINT
HOURS UNDER RESISTIVE LOAD

FIGURE 2

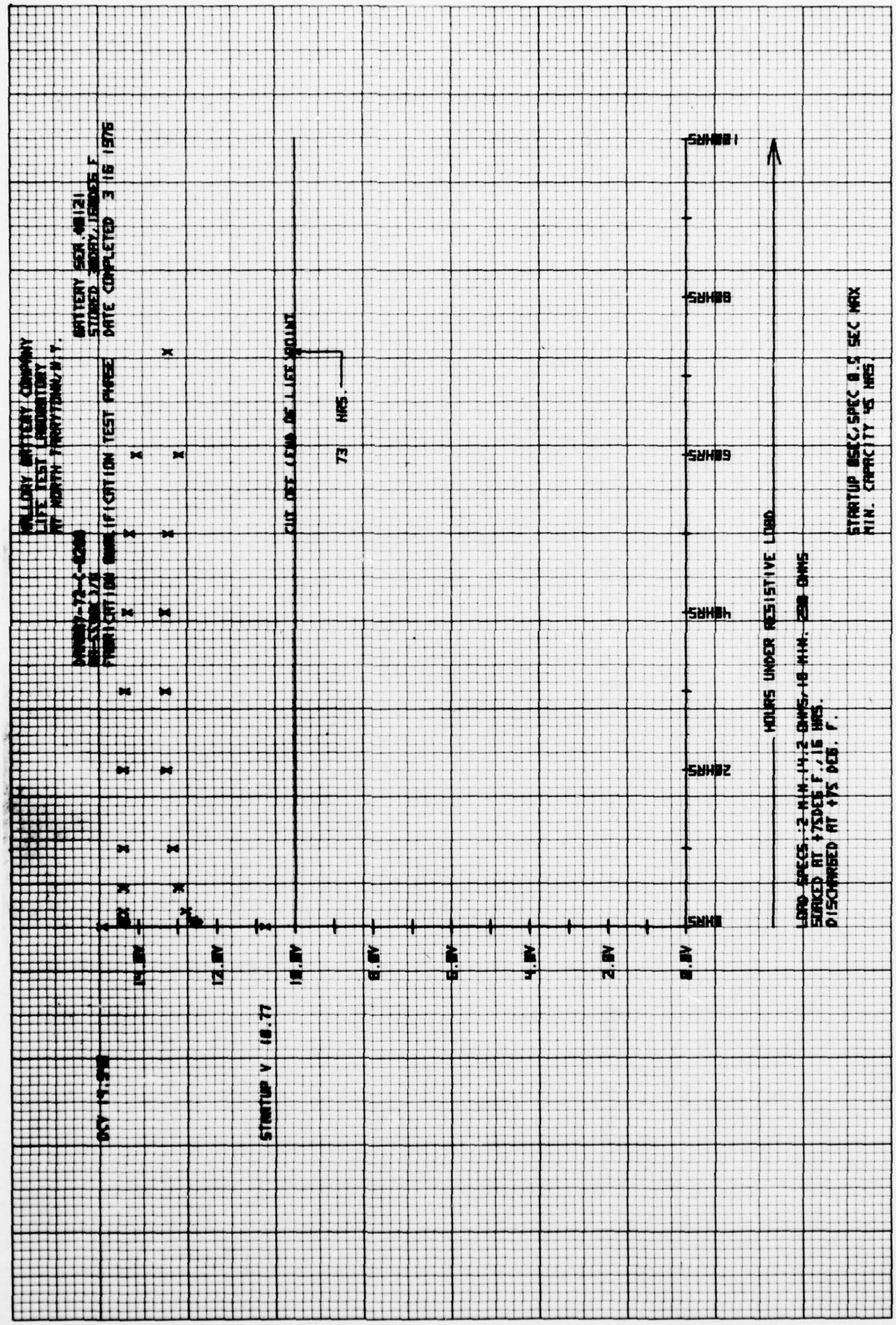

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER. 40121
DATE COMPLETED 3 16 1976
STARTUP V 10.77
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
CUT OFF (END OF LIFE) POINT
73 HRS.
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.: 2 MIN. 14.2 OHMS, 10 MIN. 290 OHMS
SOAKED AT +75DEG F., 16 HRS.
DISCHARGED AT +75 DEG. F.
STARTUP 0SEC, SPEC 0.5 SEC MAX
MIN. CAPACITY 45 HRS.

FIGURE 3

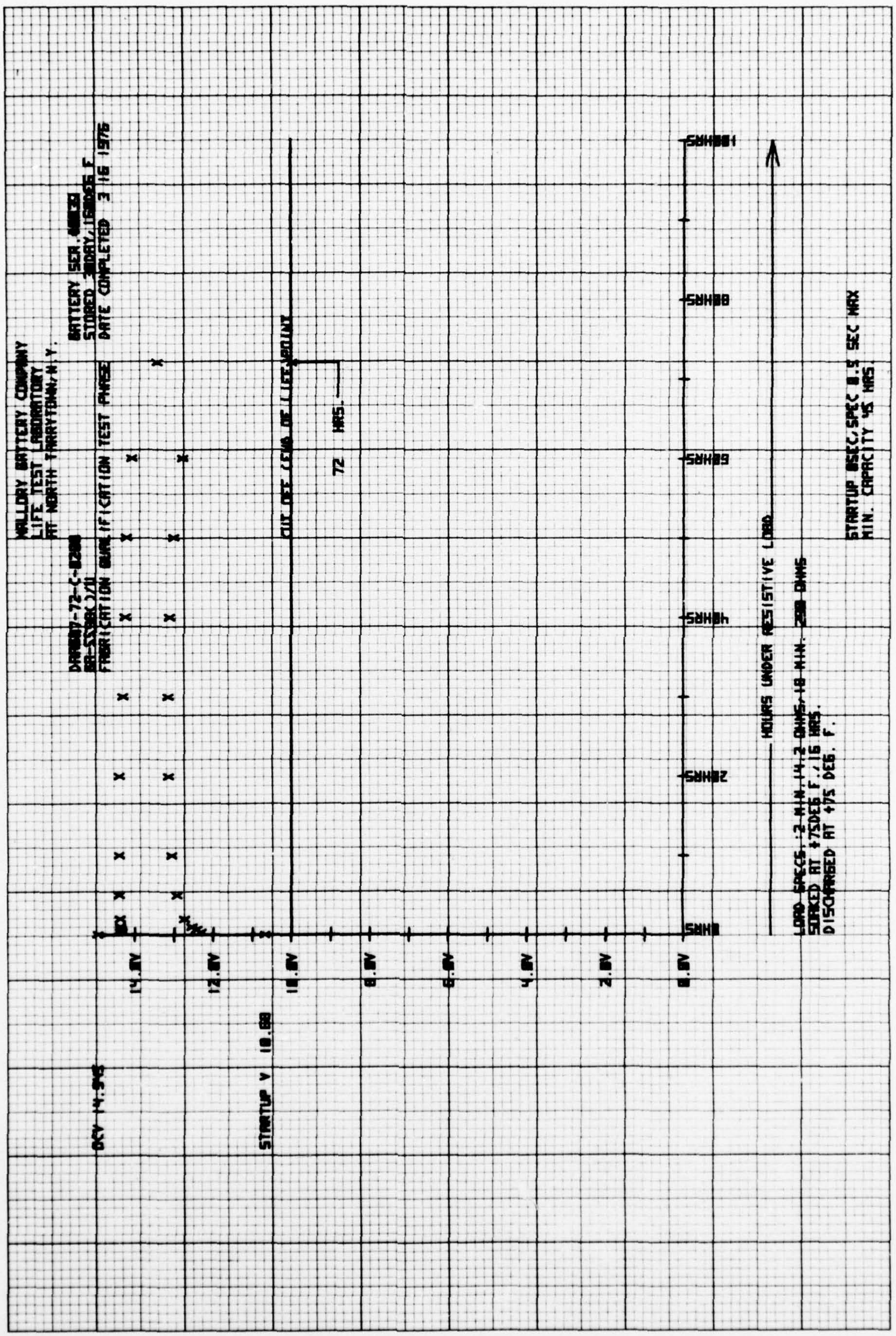
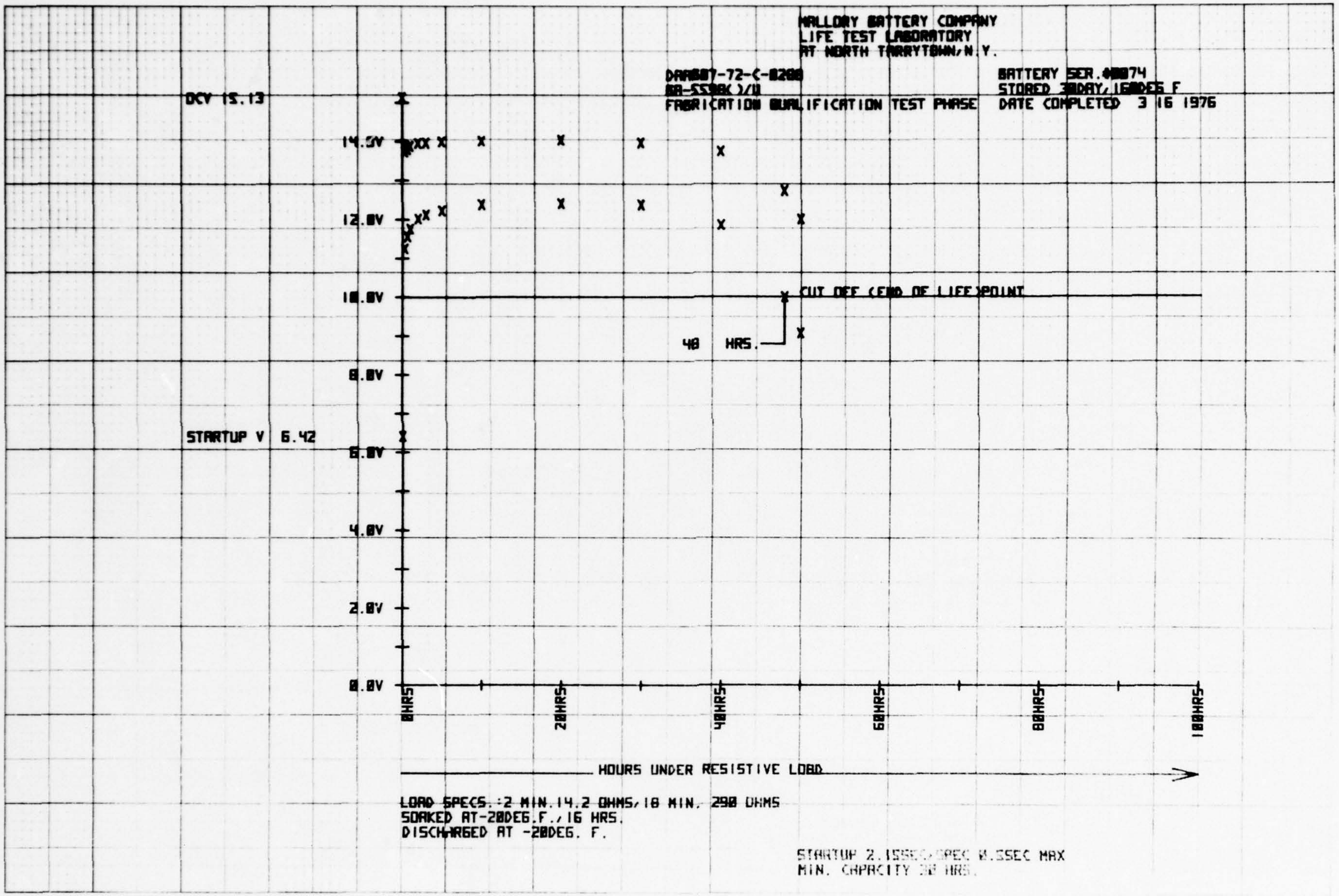
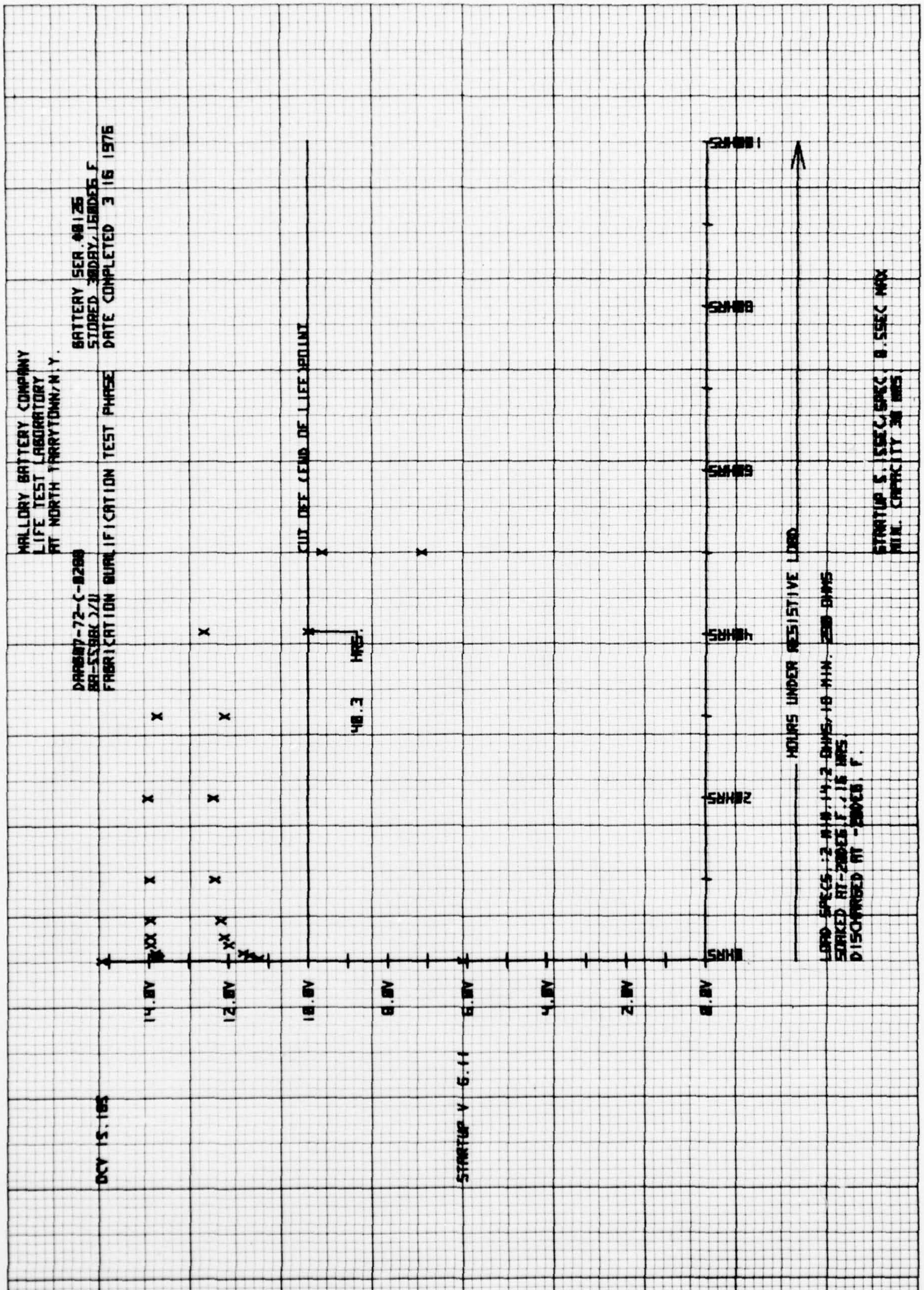

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0200
BA-5590( )/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER.
STORED 30DAY, 160DEG F
DATE COMPLETED 3 16 1976
OCV 14.945
STARTUP V 10.80
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
CUT OFF (END OF LIFE)POINT
72 HRS.
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.14.2 OHMS/18 MIN. 290 OHMS
SOAKED AT +75DEG F./16 HRS.
DISCHARGED AT +75 DEG. F.
STARTUP 0SEC/SPEC 0.5 SEC MAX
MIN. CAPACITY 45 HRS.

FIGURE 4



MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0200
BA-5598()/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER.00074
STORED 30DAY, 160DEG F
DATE COMPLETED 3 16 1976
OCV 15.13
STARTUP V 6.42
14.5V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
CUT OFF (END OF LIFE)POINT
40 HRS.
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.14.2 OHMS/18 MIN. 290 OHMS
SOAKED AT-20DEG.F./16 HRS.
DISCHARGED AT -20DEG. F.
STARTUP 2.15SEC/SPEC 0.5SEC MAX
MIN. CAPACITY 30 HRS.

FIGURE 5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LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0280
BA-5598( )/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER.00126
STORED 30DAY, 160DEG F.
DATE COMPLETED 3 16 1976
OCV 15.10S
STARTUP V 6.11
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
CUT OFF (END OF LIFE)POINT
40.3 HRS.
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.14.2 OHMS/10 MIN. 290 OHMS
SOAKED AT-20DEG.F.,16 HRS.
DISCHARGED AT -20DEG. F.
STARTUP 5.15SEC/SPEC. 0.5SEC MAX
MIN. CAPACITY 30 HRS.

FIGURE 6

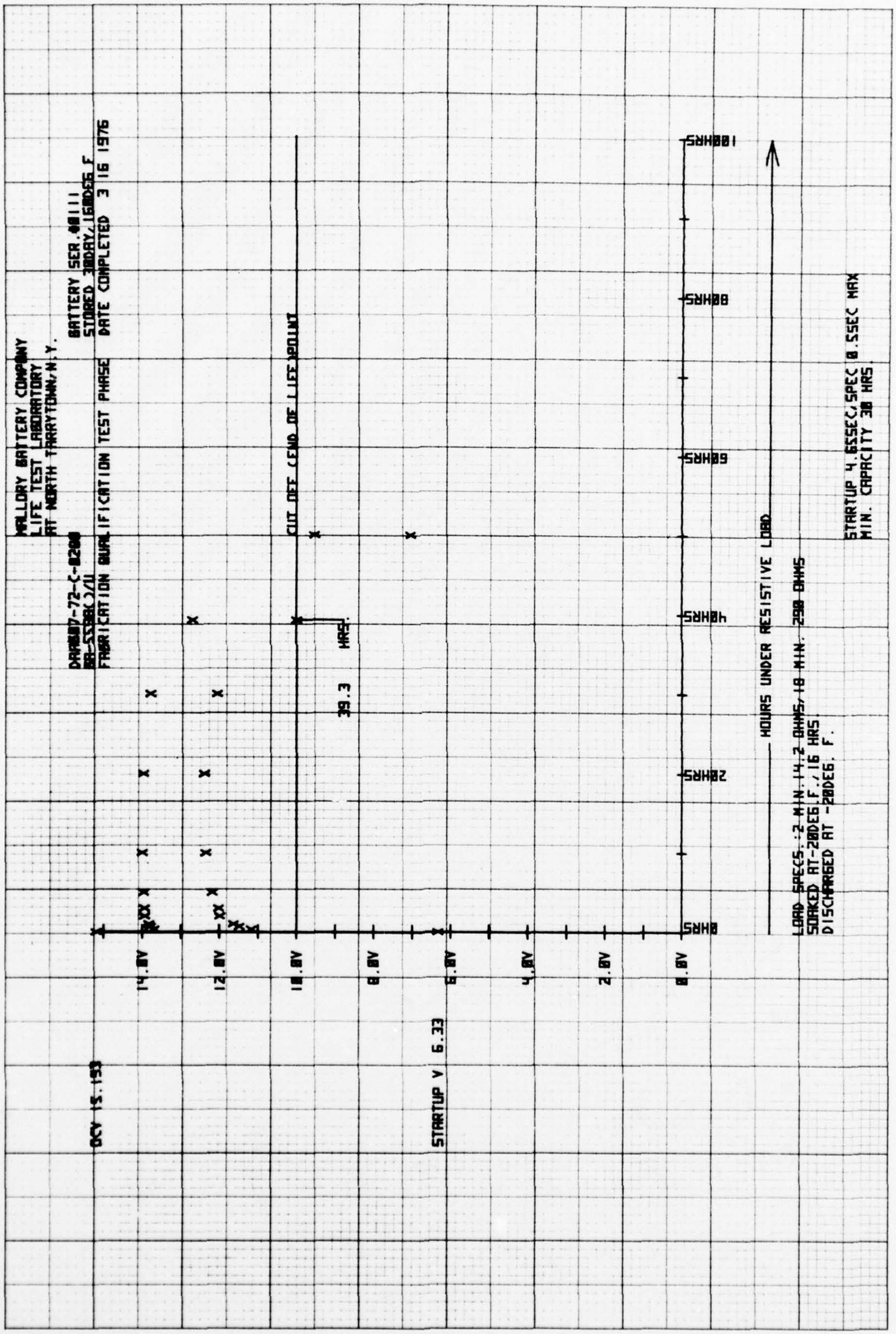
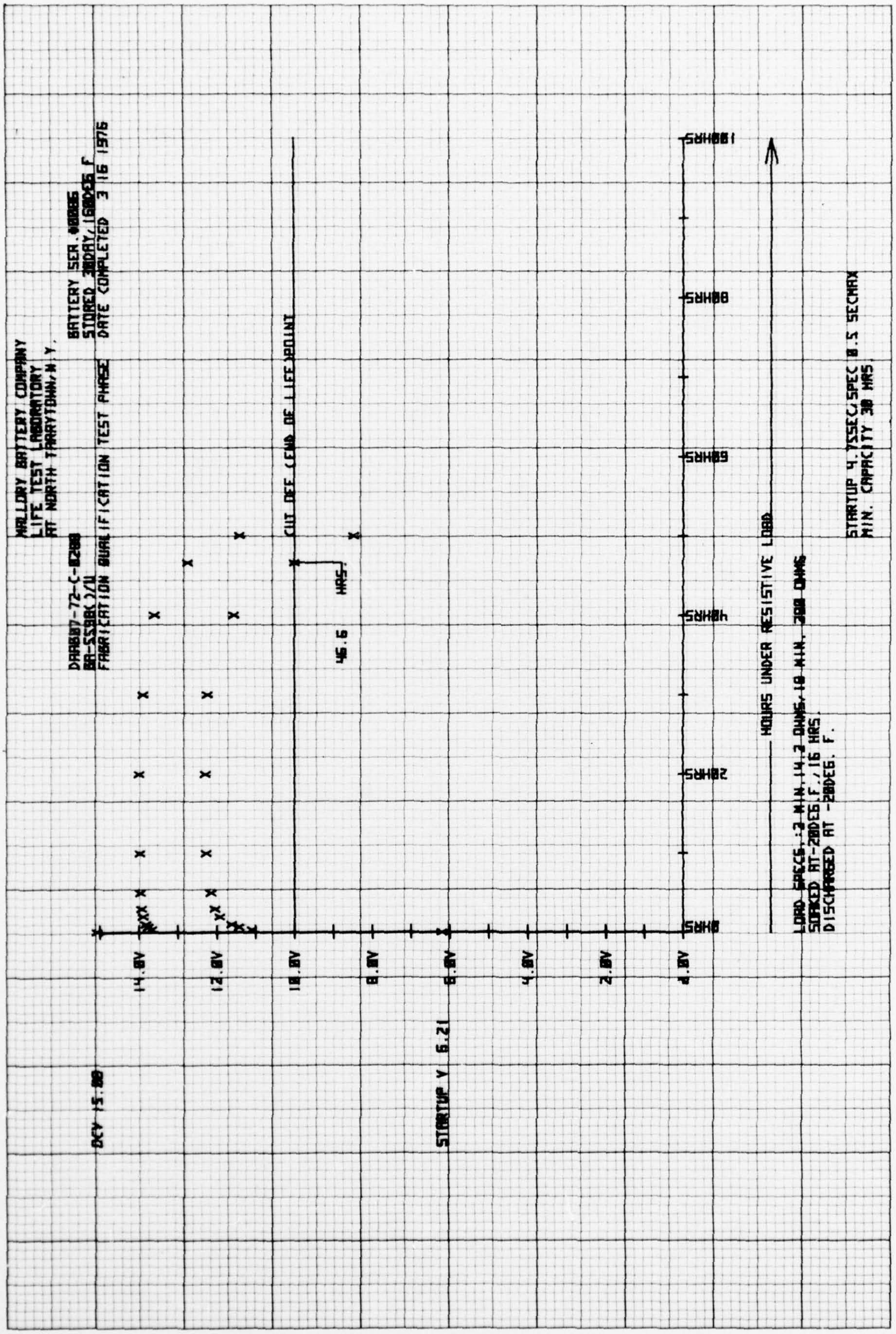
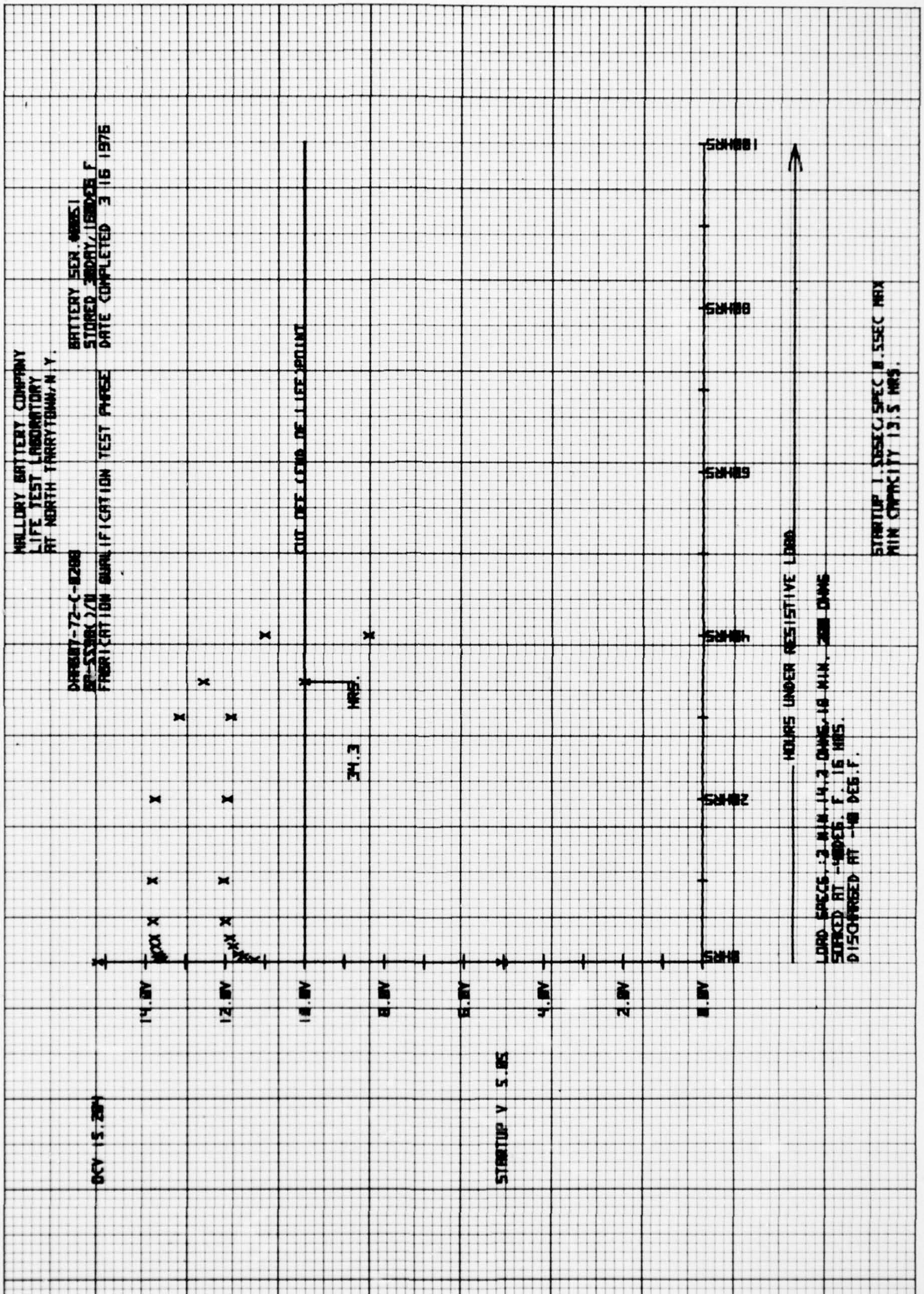

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0200
BA-5598()/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER.00111
STORED 30DAY,160DEG.F
DATE COMPLETED 3 16 1976
CUT OFF (END OF LIFE)POINT
39.3 HRS.
OCV 15.193
STARTUP V 6.33
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.14.2 OHMS/18 MIN. 200 OHMS
SOAKED AT-20DEG.F./16 HRS
DISCHARGED AT -20DEG. F.
STARTUP 4.65SEC/SPEC 0.5SEC MAX
MIN. CAPACITY 30 HRS.

FIGURE 7



MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0200
BA-5598( )/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER.#0085
STORED 30DAY,160DEG F
DATE COMPLETED 3 16 1976
CUT OFF (END OF LIFE)POINT
45.6 HRS.
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
DEV 15.00
STARTUP V 6.21
LOAD SPECS.:2 MIN.14.2 OHMS,10 MIN. 200 OHMS
SOAKED AT-20DEG.F.,16 HRS
DISCHARGED AT -20DEG. F.
STARTUP 4.75SEC,SPEC 8.5 SECMAX
MIN. CAPACITY 30 HRS

FIGURE 8



MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0200
BA-5590( )/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER.
STORED 30DAY, 160DEG F
DATE COMPLETED 3 16 1976
OCV 15.20V
STARTUP V 5.05
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
CUT OFF (END OF LIFE)POINT
34.3 HRS.
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:3 MIN.14.3 OHMS, 10 MIN. 200 OHMS
SOAKED AT -40DEG. F. 16 HRS.
DISCHARGED AT -40 DEG.F.
STARTUP 1.56SEC, SPEC 0.5SEC MAX
MIN CAPACITY 13.5 HRS.

FIGURE 9

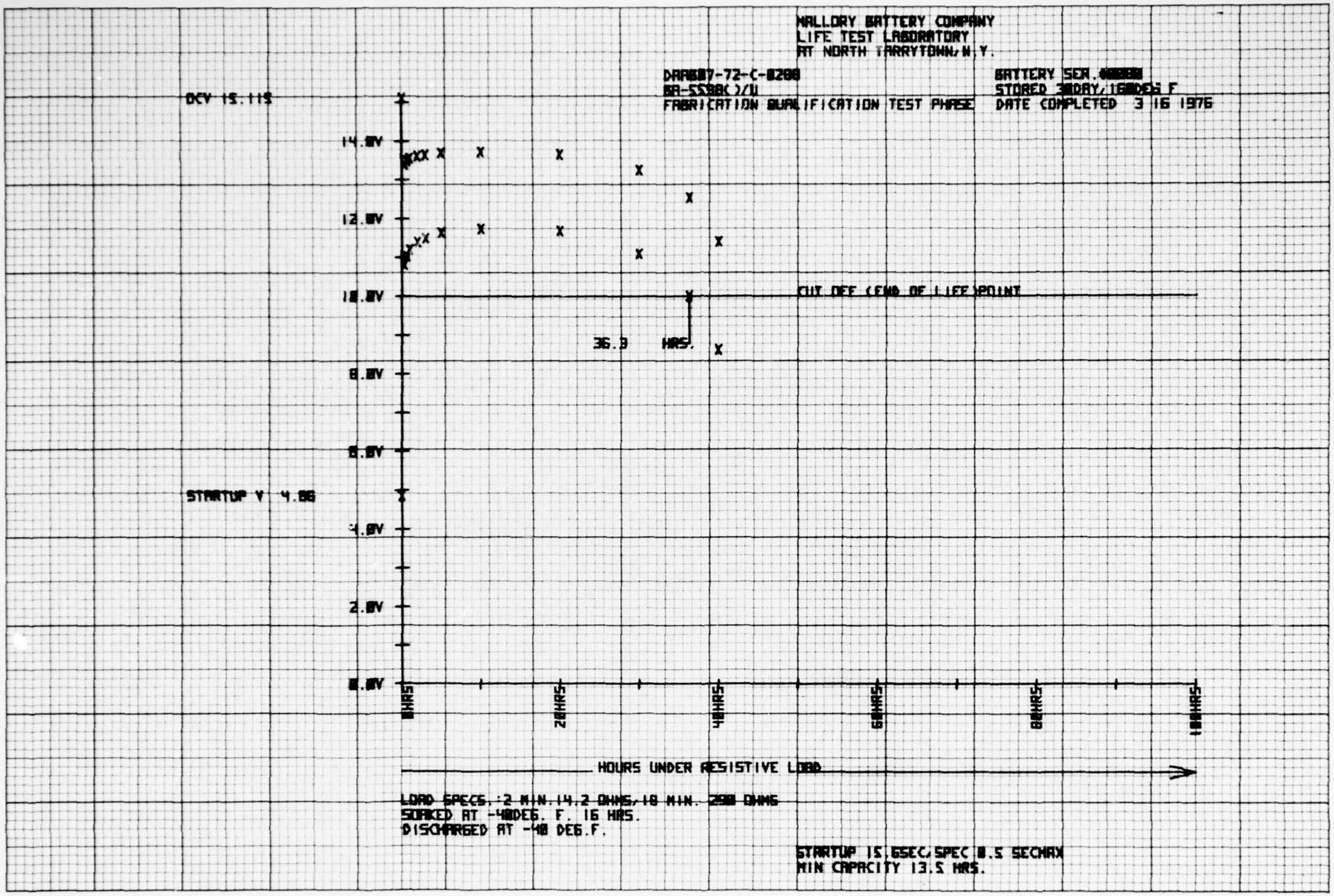

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0200
BA-5598( )/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER.[redacted]
STORED 30DAY/160DEG F
DATE COMPLETED 3 16 1976
OCV 15.115
STARTUP V 4.86
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
CUT OFF (END OF LIFE)POINT
36.3 HRS.
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS. 2 MIN.14.2 OHMS/10 MIN. 200 OHMS
SOAKED AT -40DEG. F. 16 HRS.
DISCHARGED AT -40 DEG.F.
STARTUP IS.6SEC/SPEC 0.5 SECMAX
MIN CAPACITY 13.5 HRS.

FIGURE 10

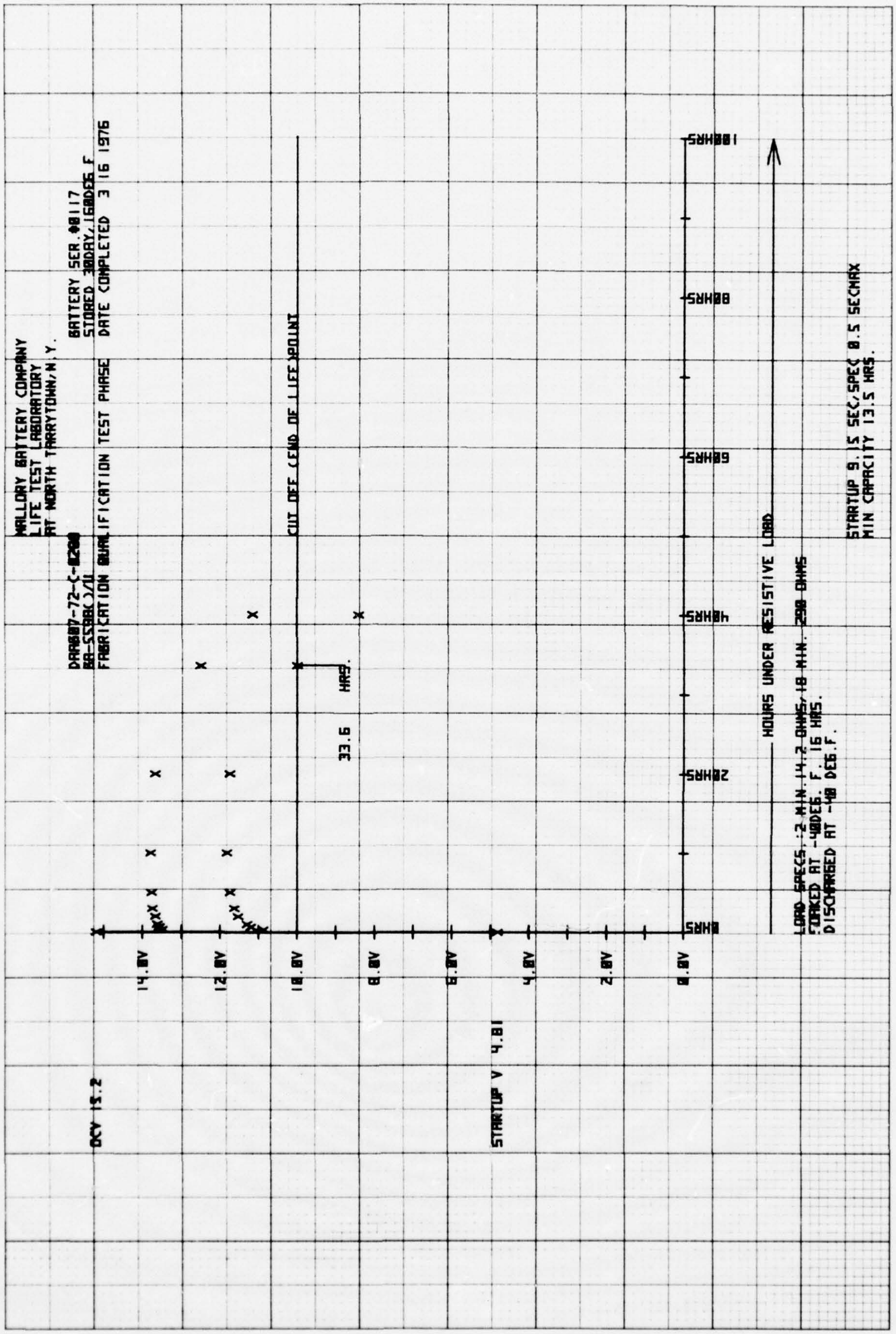

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0200
BA-5598( )/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER.00117
STORED 30DAY, 160DEG.F
DATE COMPLETED 3 16 1976
CUT OFF (END OF LIFE)POINT
33.6 HRS.
DCV 15.2
STARTUP V 4.81
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.14.2 OHMS/10 MIN. 290 OHMS
FORCED AT -40DEG. F. 16 HRS.
DISCHARGED AT -40 DEG.F.
STARTUP 0.15 SEC/SPEC 0.5 SECMAX
MIN CAPACITY 13.5 HRS.

FIGURE 11

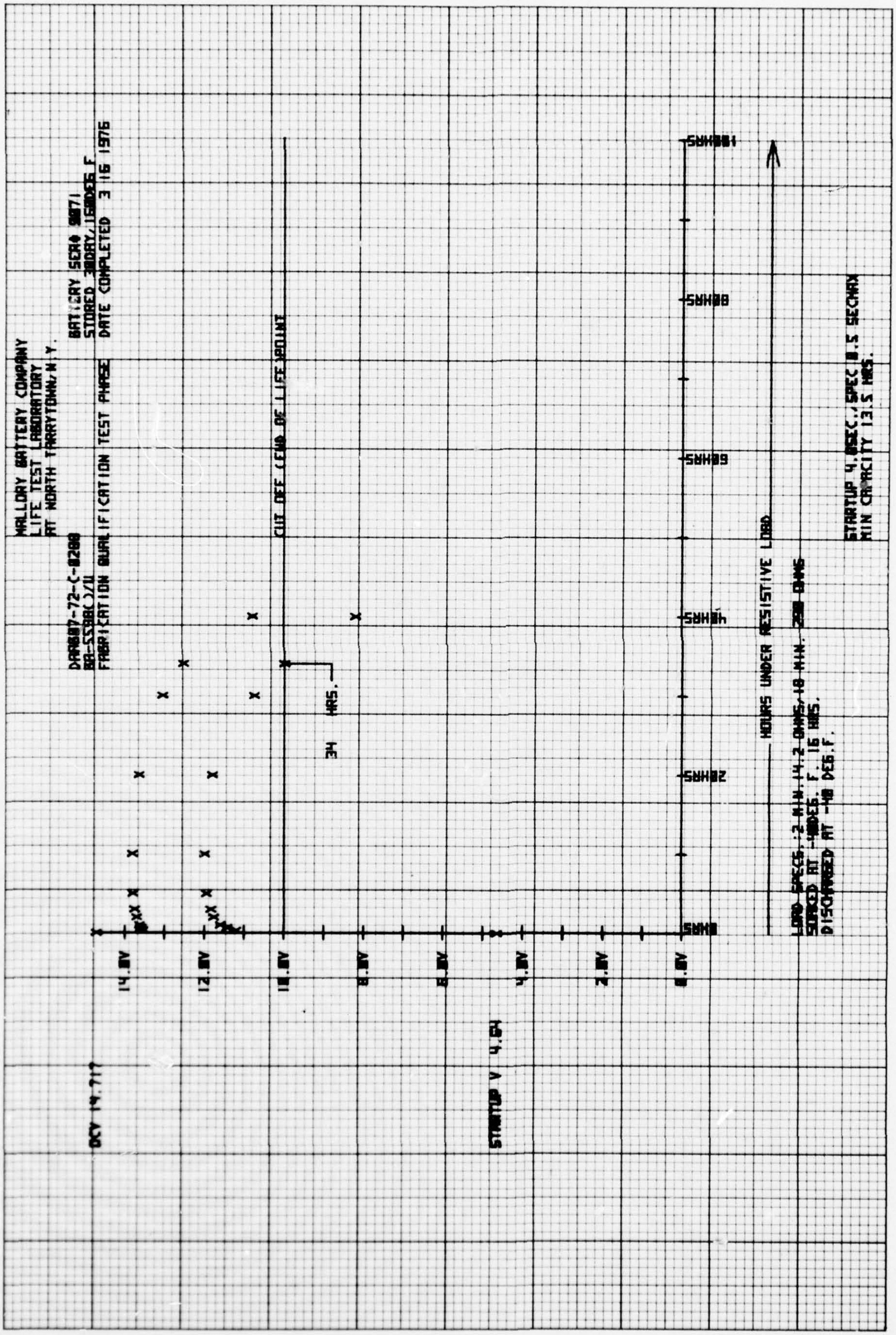

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
BATTERY SER# 9071
STORED 30DAY, 160DEG F
DATE COMPLETED 3 16 1976
DAAB07-72-C-0200
BA-5598( )/U
FABRICATION QUALIFICATION TEST PHASE
CUT OFF (END OF LIFE)POINT
34 HRS.
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
OCV 14.717
STARTUP V 4.84
LOAD SPECS.-2 MIN.(4.2 OHMS)-18 MIN. 200 OHMS
STORED AT -40DEG. F. 16 HRS.
DISCHARGED AT -40 DEG.F.
STARTUP 4.0SEC.,SPEC 0.5 SECMAX
MIN CAPACITY 13.5 HRS.

FIGURE 12

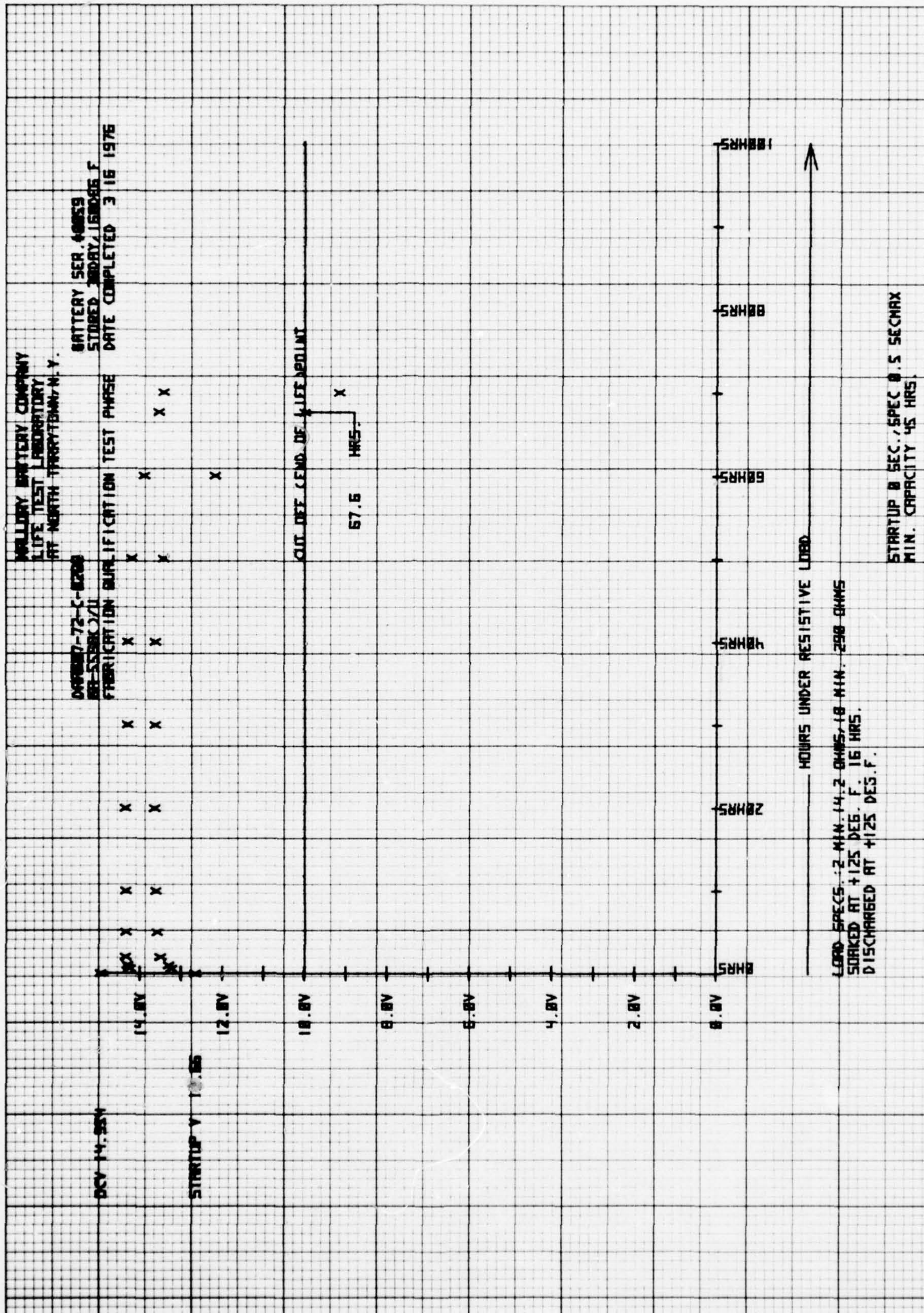

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0280
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER. 40659
STORED 30DAY/160DEG F
DATE COMPLETED 3 16 1976
OCV 14.35V
STARTUP V
CUT OFF (END OF LIFE)POINT
67.6 HRS.
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS: 2 MIN.14.2 OHMS/10 MIN. 290 OHMS
SOAKED AT +125 DEG. F. 16 HRS.
DISCHARGED AT +125 DEG.F.
STARTUP 0 SEC.,SPEC 0.5 SECMAX
MIN. CAPACITY 45 HRS.

FIGURE 13

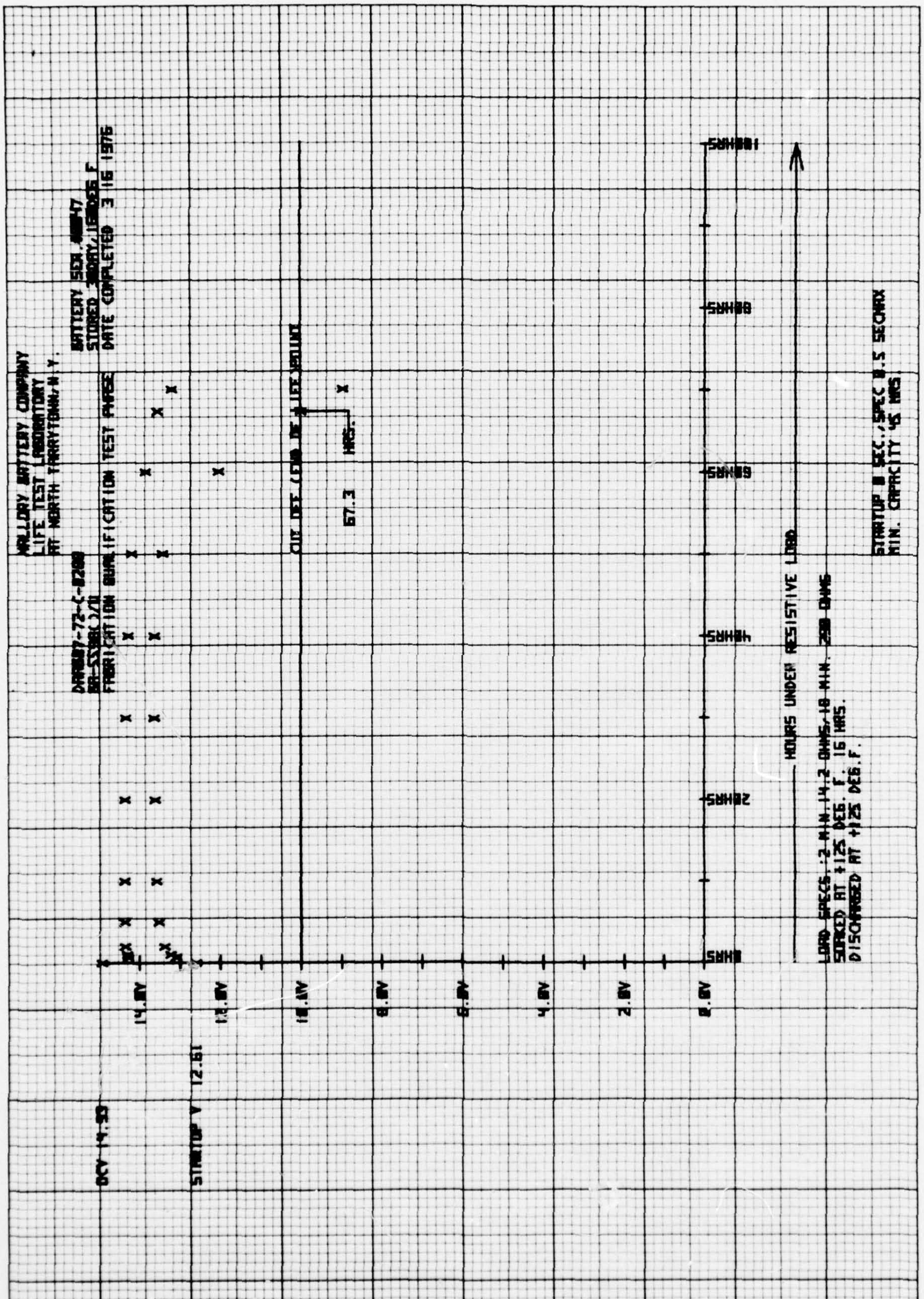

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN,N.Y.
DAAB07-72-C-0200
BA-5598()/U
FABRICATION QUALIFICATION TEST PHASE
DATE COMPLETED 3 16 1976
OCV 14.93
STARTUP V 12.61
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
CUT OFF (END OF LIFE)POINT
67.3 HRS.
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.14.2 OHMS/18 MIN. 290 OHMS
SOAKED AT +125 DEG. F. 16 HRS.
DISCHARGED AT +125 DEG.F.
STARTUP 0 SEC.,SPEC 0.5 SECMAX
MIN. CAPACITY 45 HRS.

FIGURE 14

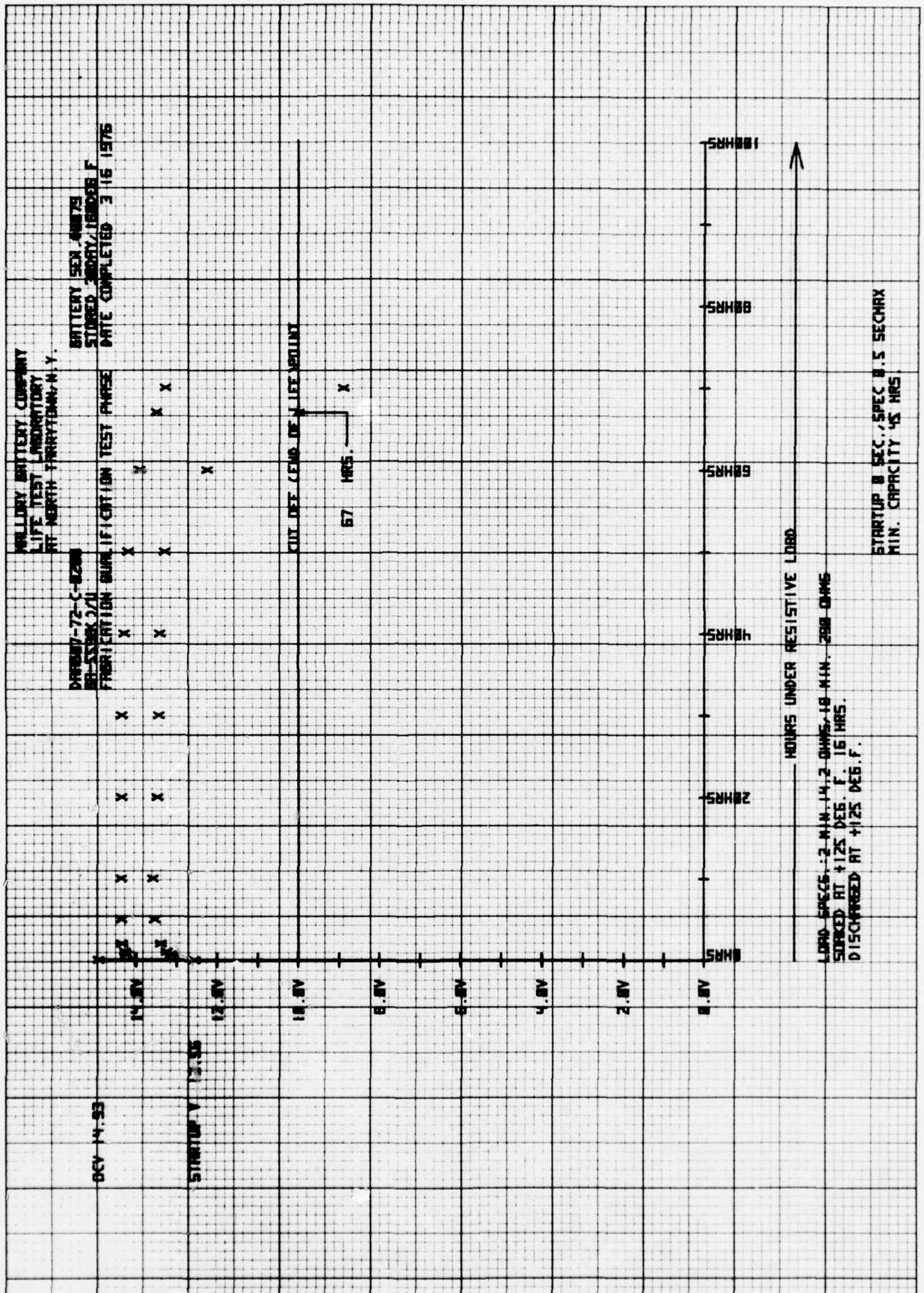

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
BATTERY SER.00079
STORED 30DAY,160DEG F
DATE COMPLETED 3 16 1976
FABRICATION QUALIFICATION TEST PHASE
DEV 14.93
STARTUP V
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
CUT OFF (END OF LIFE)POINT
67 HRS.
HOURS UNDER RESISTIVE LOAD
STORED AT +125 DEG. F. 16 HRS.
DISCHARGED AT +125 DEG.F.
STARTUP 0 SEC.,SPEC 0.5 SECMAX
MIN. CAPACITY 45 HRS

FIGURE 15

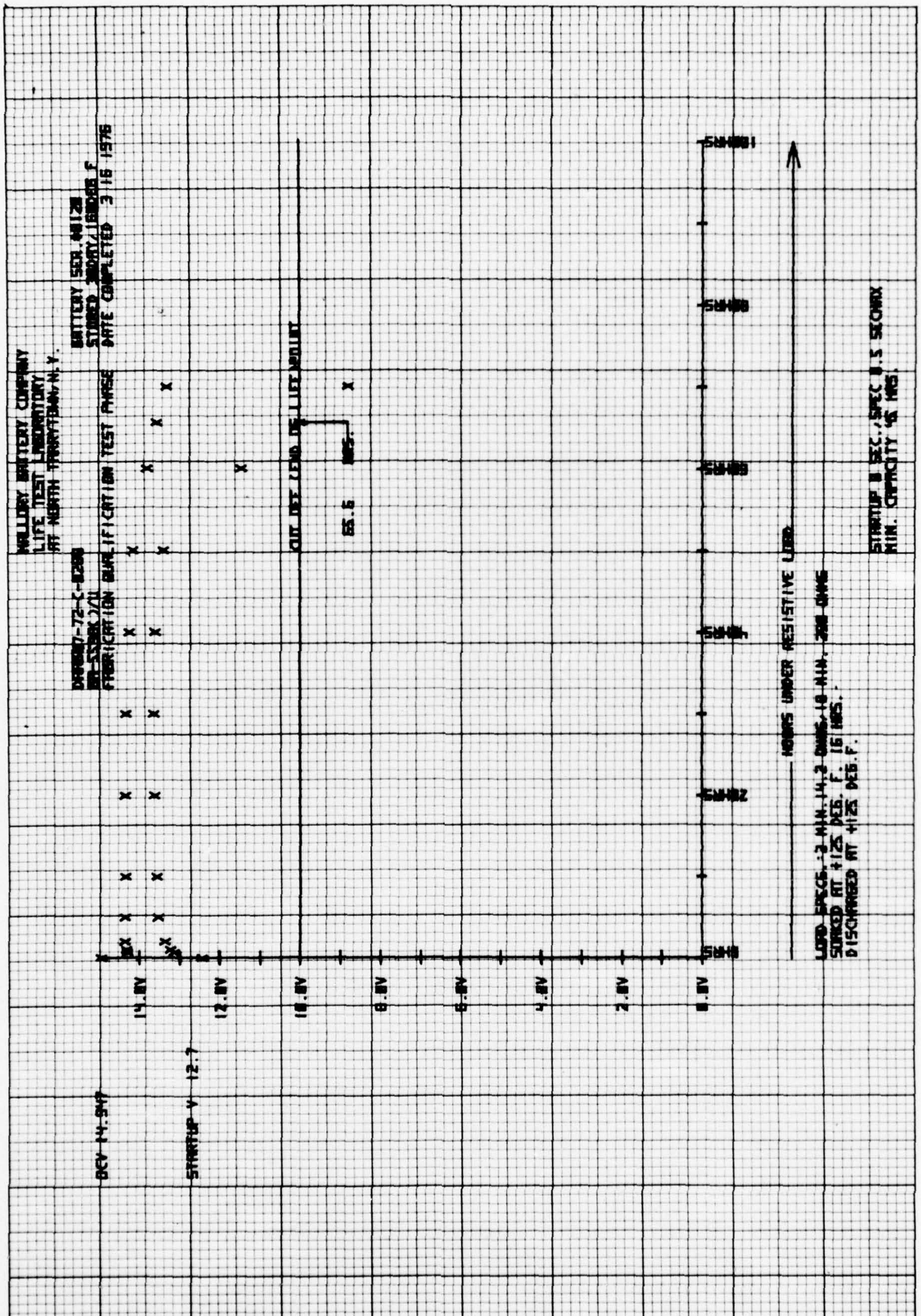

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
FABRICATION QUALIFICATION TEST PHASE
DATE COMPLETED 3 16 1976
OCV 14.947
STARTUP V 12.7
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
CUT OFF (END OF LIFE) POINT
65.6 HRS.
HOURS UNDER RESISTIVE LOAD
SOAKED AT +125 DEG. F. 16 HRS.
DISCHARGED AT +125 DEG.F.
MIN. CAPACITY 45 HRS.

FIGURE 16

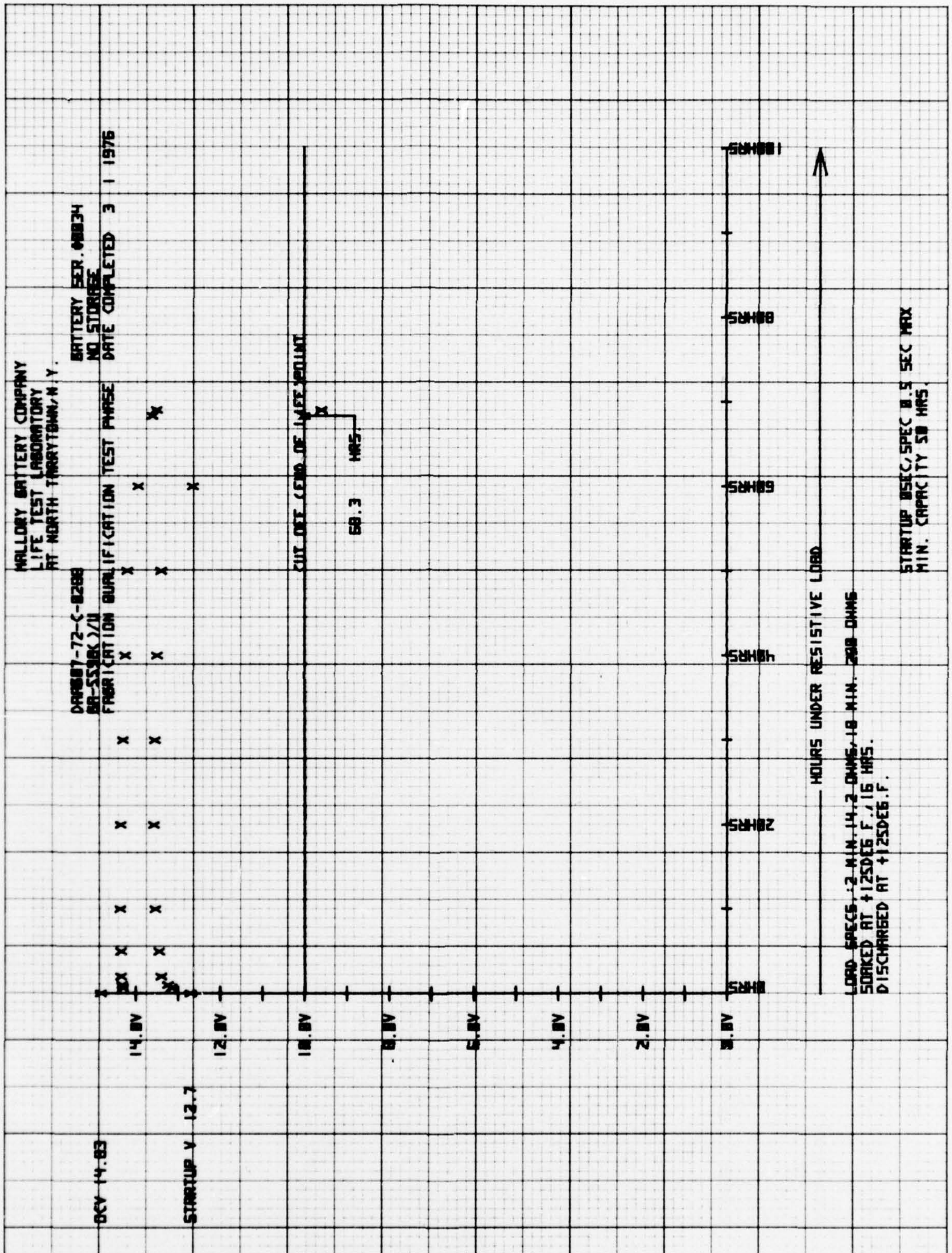

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0200
BA-5598( )/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER.00034
NO STORAGE
DATE COMPLETED 3 1 1976
OCV 14.03
STARTUP V 12.7
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
CUT OFF (END OF LIFE)POINT
60.3 HRS.
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.14.2 OHMS/18 MIN. 200 OHMS
SOAKED AT +125DEG F./16 HRS.
DISCHARGED AT +125DEG.F.
STARTUP 0SEC/SPEC 0.5 SEC MAX
MIN. CAPACITY 50 HRS.

FIGURE 17

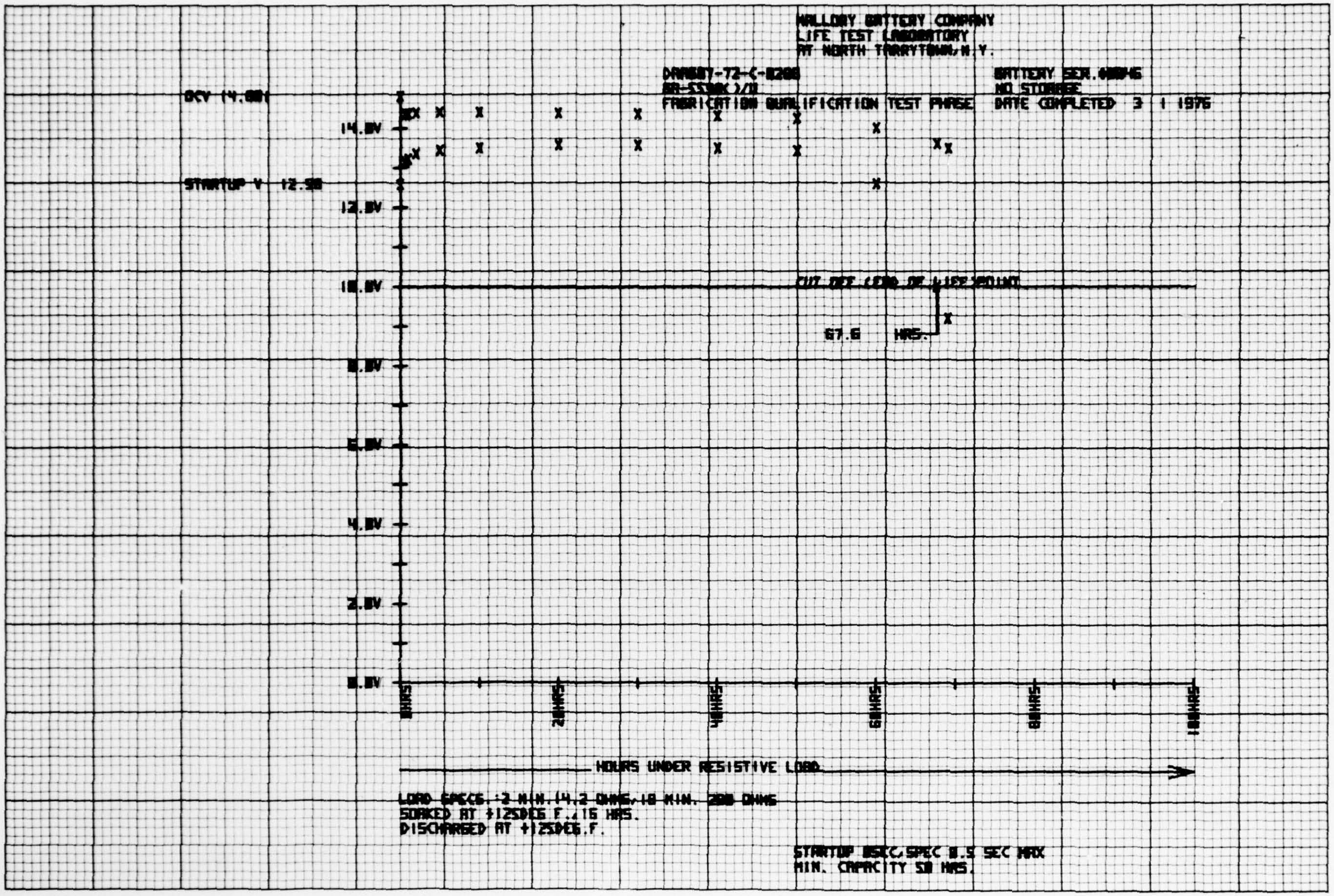
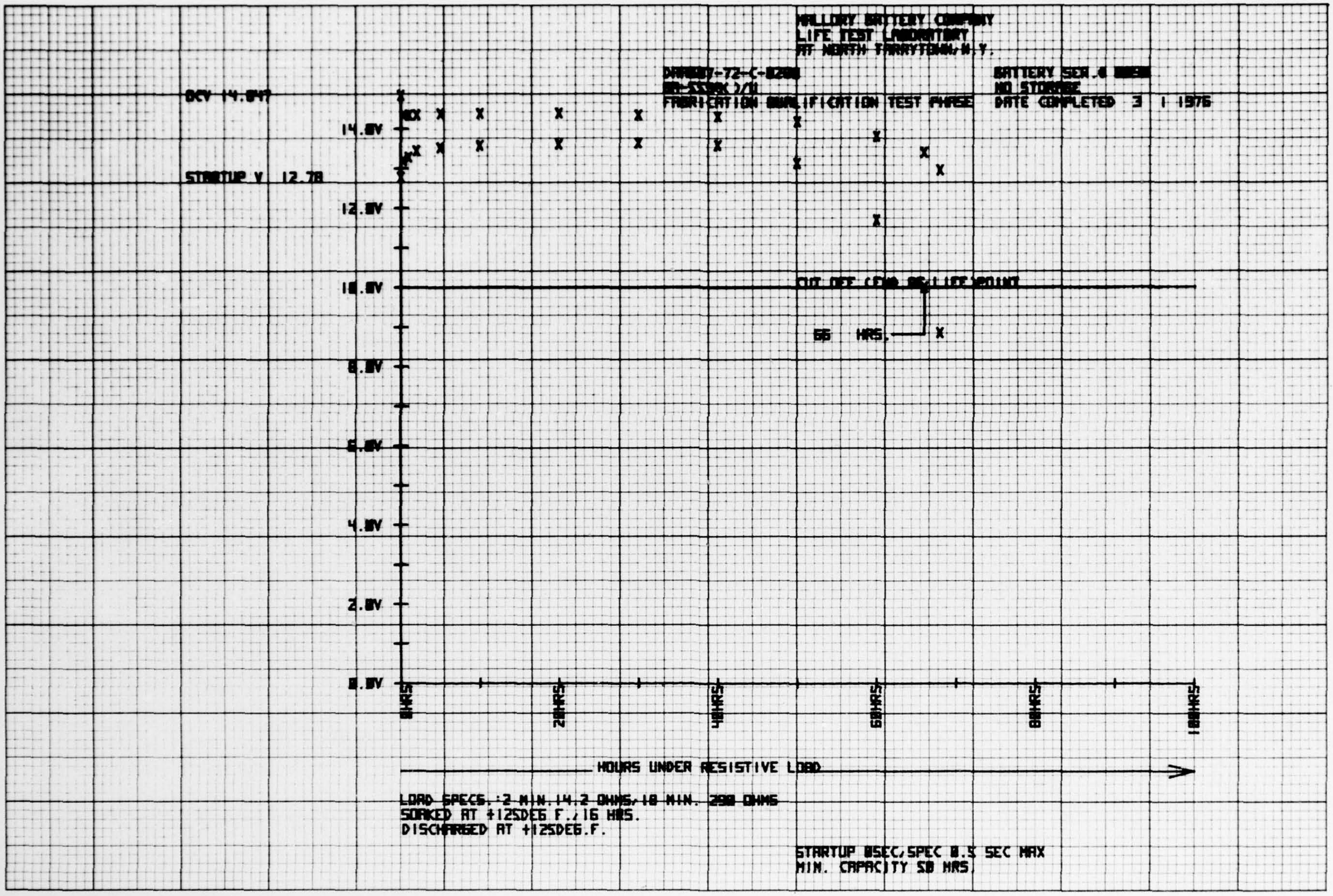

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
FABRICATION QUALIFICATION TEST PHASE
NO STORAGE
DATE COMPLETED 3 1 1976
OCV 14.00
STARTUP V 12.50
14.0V
12.0V
10.0V
2.0V
CUT OFF END OF LIFE POINT
67.6 HRS.
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
SOAKED AT +125DEG F., 16 HRS.
DISCHARGED AT +125DEG.F.
MIN. CAPACITY 50 HRS.

FIGURE 18



MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
FABRICATION QUALIFICATION TEST PHASE
NO STORAGE
DATE COMPLETED 3 1 1976
OCV 14.04?
STARTUP V 12.78
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
CUT OFF (END OF LIFE) POINT
66 HRS.
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.14.2 OHMS/18 MIN. 290 OHMS
SOAKED AT +125DEG F./16 HRS.
DISCHARGED AT +125DEG.F.
STARTUP 0SEC/SPEC 0.5 SEC MAX
MIN. CAPACITY 50 HRS.

FIGURE 19

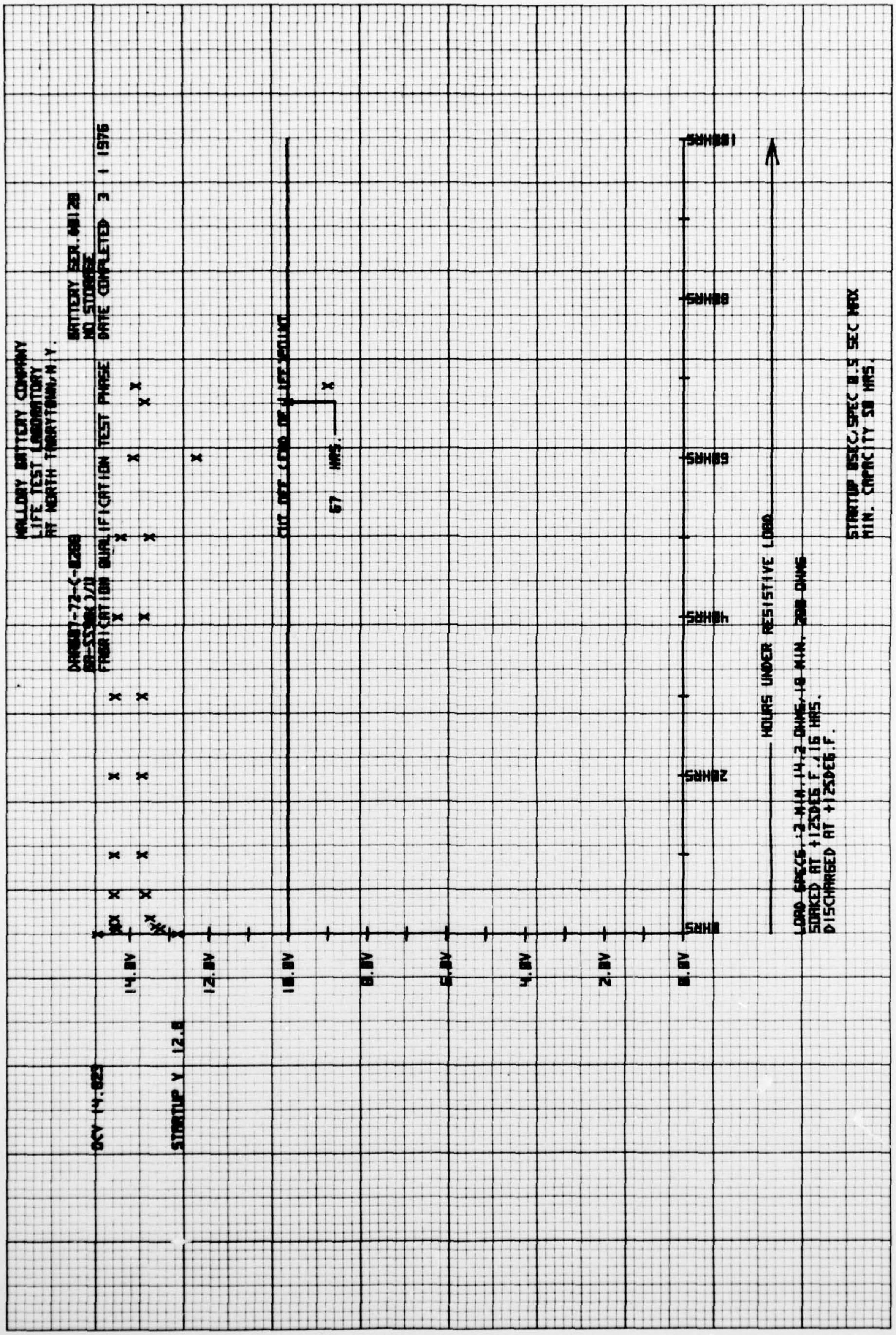
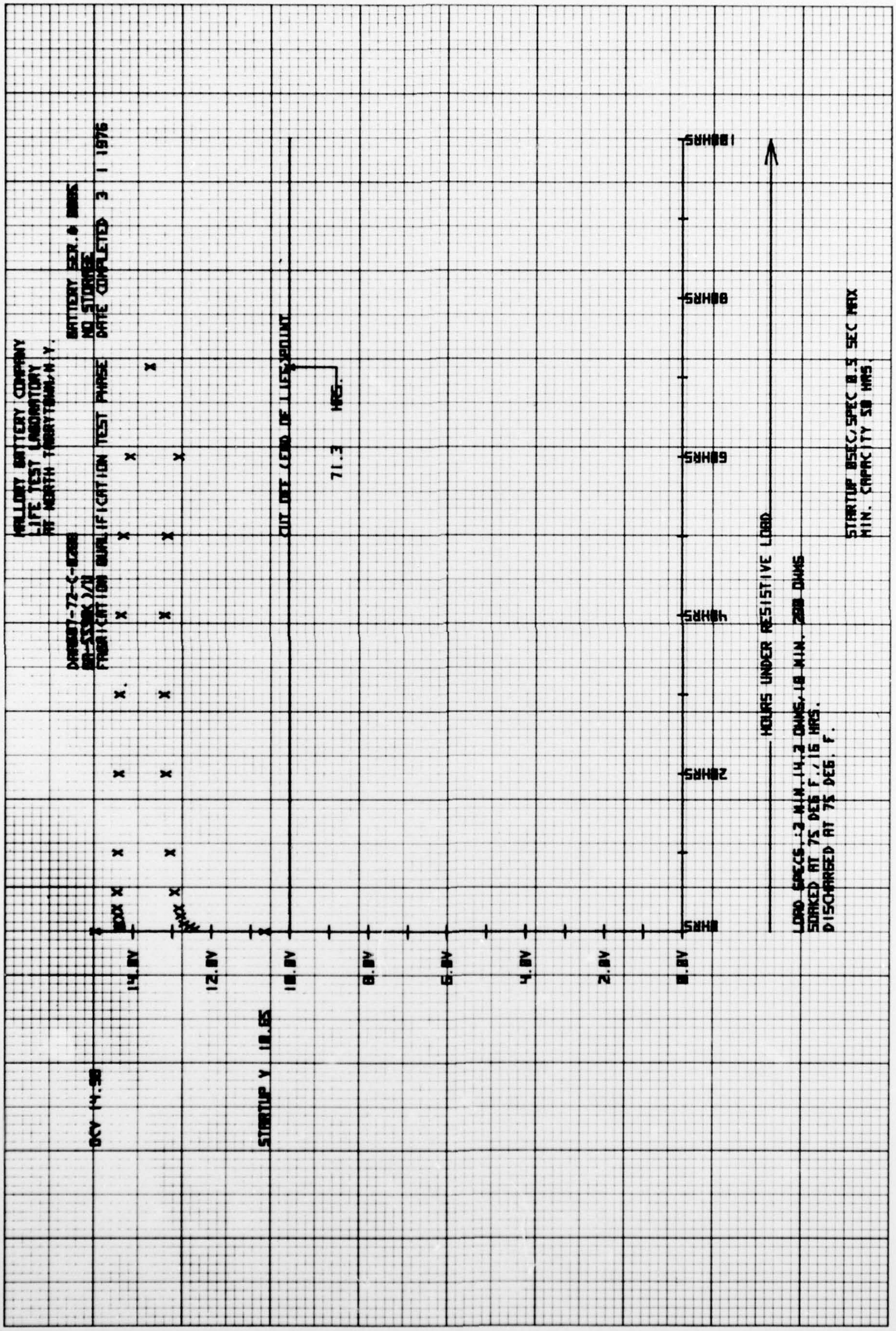

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0288
BA-5590( )/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER.00128
NO STORAGE
DATE COMPLETED 3 1 1976
OCV 14.025
STARTUP V 12.8
CUT OFF
67 HRS.
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS. 2 MIN. 14.2 OHMS, 10 MIN. 200 OHMS
SOAKED AT +125DEG F. 16 HRS.
DISCHARGED AT +125DEG.F.
STARTUP 0SEC, SPEC 0.5 SEC MAX
MIN. CAPACITY 50 HRS.

FIGURE 20



MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
FABRICATION QUALIFICATION TEST PHASE
NO STORAGE
DATE COMPLETED 3 1 1976
OCV 14.90
STARTUP V 10.65
CUT OFF (END OF LIFE) POINT
71.3 HRS.
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
SOAKED AT 75 DEG F./16 HRS.
DISCHARGED AT 75 DEG. F.
MIN. CAPACITY 50 HRS.

FIGURE 21

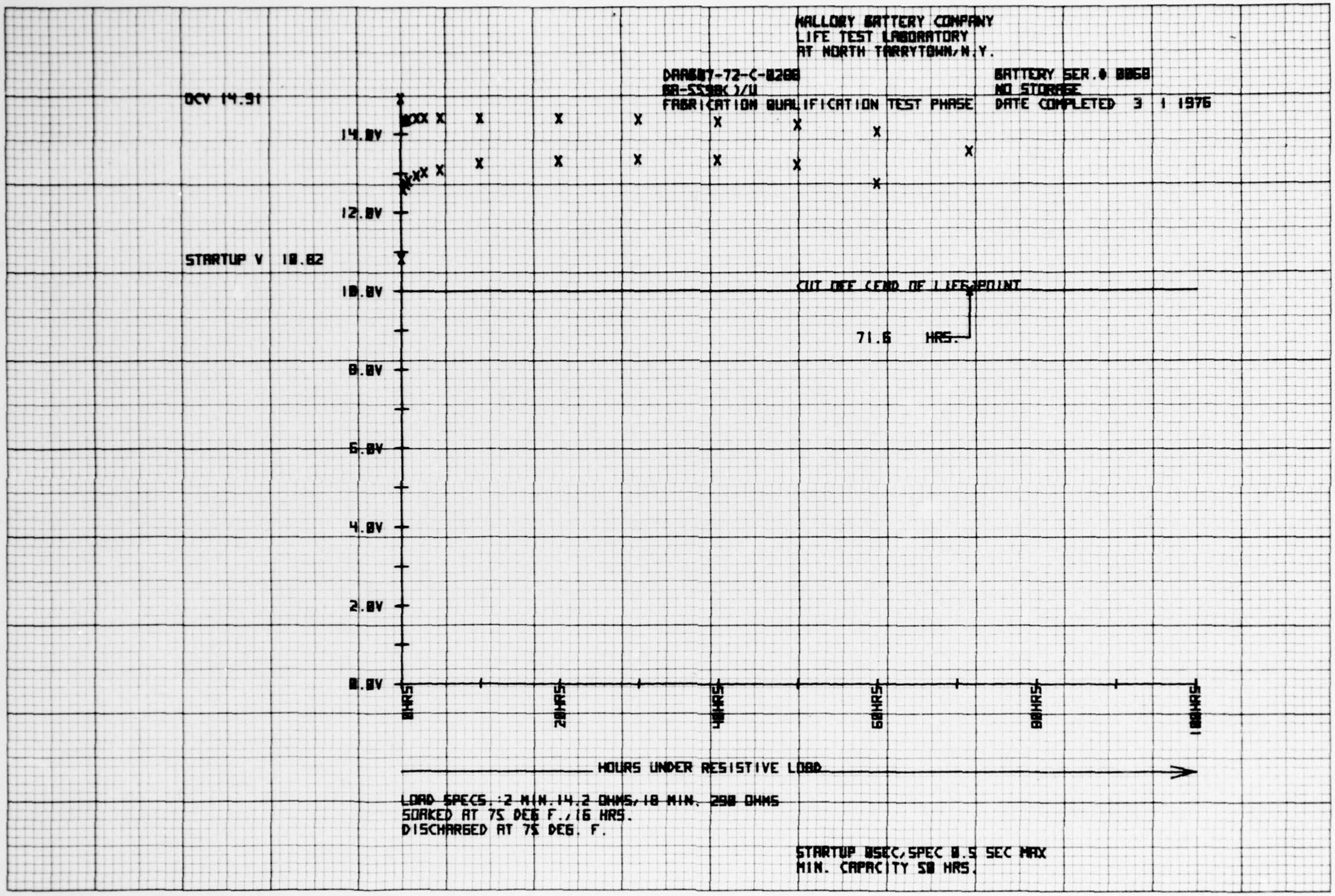

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0200
BA-5598( )/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER.# 0060
NO STORAGE
DATE COMPLETED 3 1 1976
OCV 14.91
STARTUP V 10.82
CUT OFF (END OF LIFE)POINT
71.6 HRS.
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.14.2 OHMS/18 MIN. 290 OHMS
SOAKED AT 75 DEG F./16 HRS.
DISCHARGED AT 75 DEG. F.
STARTUP 0SEC,SPEC 0.5 SEC MAX
MIN. CAPACITY 50 HRS.

FIGURE 22

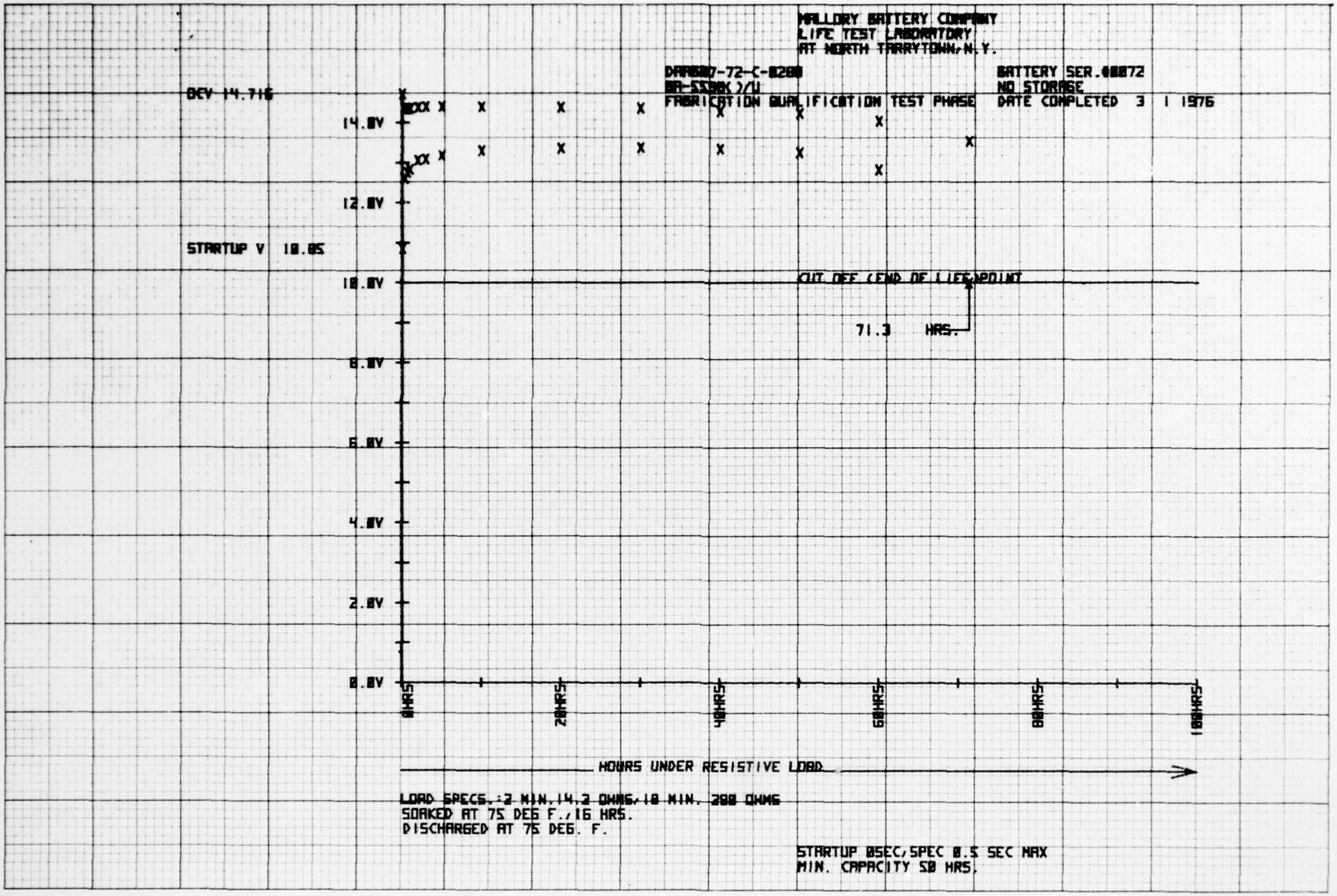
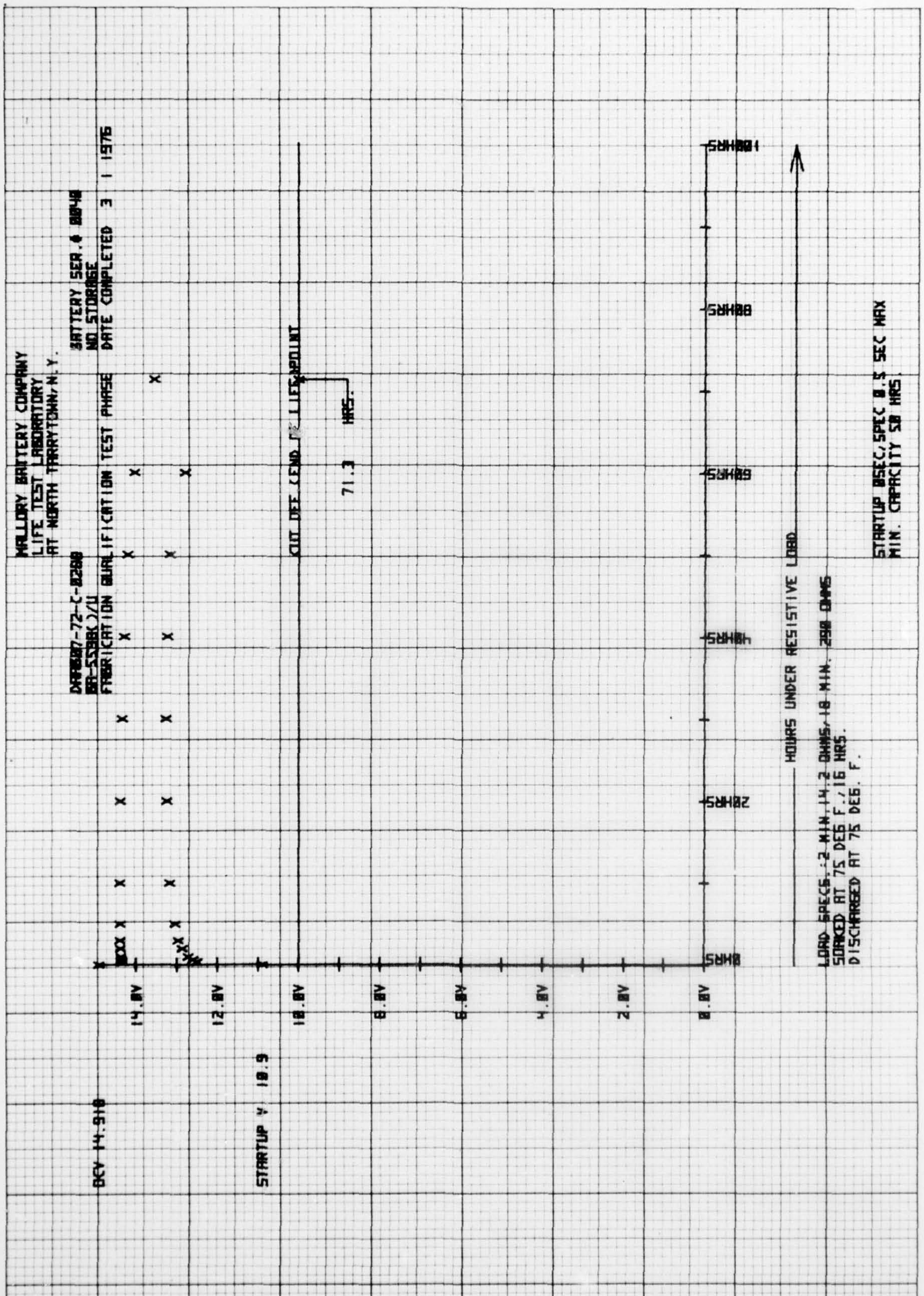

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0200
BA-5590( )/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER.00872
NO STORAGE
DATE COMPLETED 3 1 1976
DEV 14.716
STARTUP V 10.85
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
CUT OFF (END OF LIFE)POINT
71.3 HRS.
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.14.2 OHMS/10 MIN. 200 OHMS
SOAKED AT 75 DEG F./16 HRS.
DISCHARGED AT 75 DEG. F.
STARTUP 0SEC/SPEC 0.5 SEC MAX
MIN. CAPACITY 50 HRS.

FIGURE 23



MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0280
BA-5598( )/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER.# 0048
NO STORAGE
DATE COMPLETED 3 1 1976
CUT OFF (END OF LIFE) POINT
71.3 HRS.
OCV 14.918
STARTUP V. 10.9
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.14.2 OHMS,18 MIN. 290 OHMS
SOAKED AT 75 DEG F./16 HRS.
DISCHARGED AT 75 DEG. F.
STARTUP 0SEC,SPEC 0.5 SEC MAX
MIN. CAPACITY 50 HRS.

FIGURE 24

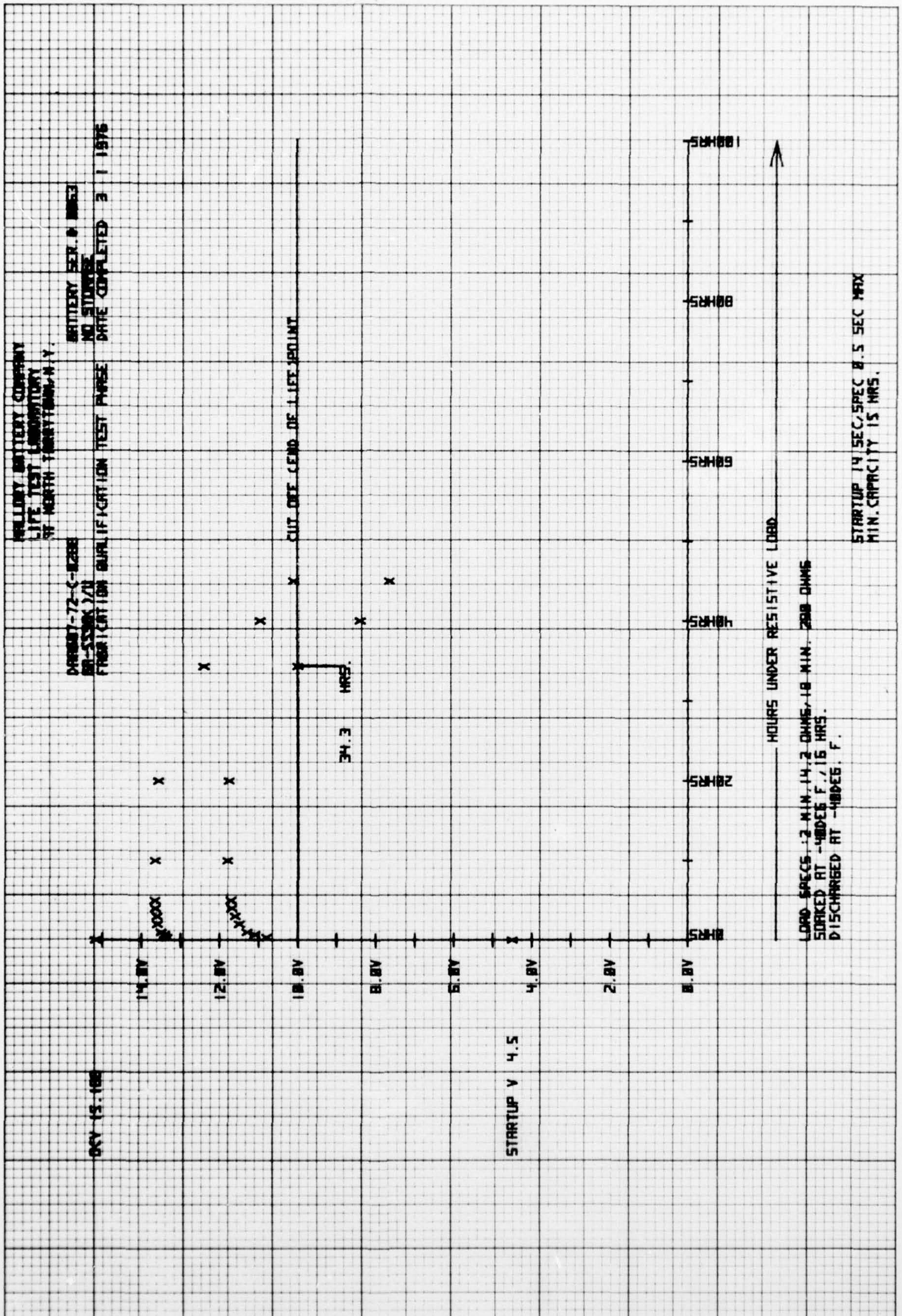

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
NORTH TARRYTOWN,N.Y.
FABRICATION QUALIFICATION TEST PHASE
NO STORAGE
DATE COMPLETED 3 1 1976
CUT OFF (END OF LIFE)POINT
34.3 HRS.
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS :2 MIN.14.2 OHMS,18 MIN. 200 OHMS
SOAKED AT -40DEG F./16 HRS.
DISCHARGED AT -40DEG. F.
STARTUP 14 SEC,SPEC 0.5 SEC MAX
MIN.CAPACITY 15 HRS.
STARTUP V 4.5

FIGURE 25

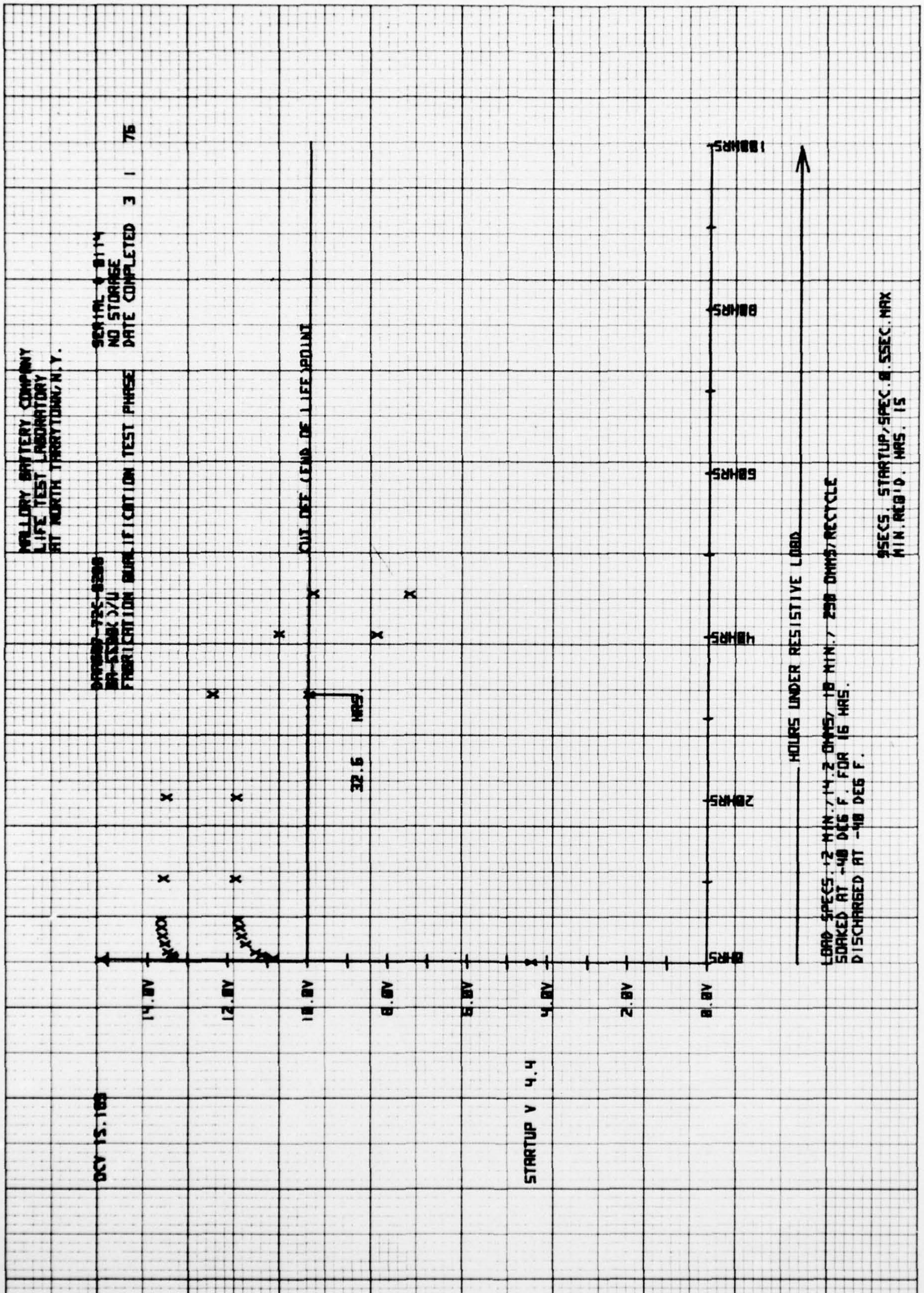

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
FABRICATION QUALIFICATION TEST PHASE
NO STORAGE
DATE COMPLETED 3 1 76
CUT OFF (END OF LIFE)POINT
32.6 HRS.
STARTUP V 4.4
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN./14.2 OHMS/ 10 MIN./ 250 OHMS/RECYCLE
SOAKED AT -40 DEG F. FOR 16 HRS.
DISCHARGED AT -40 DEG F.
9SECS. STARTUP/SPEC.0.5SEC.MAX
MIN.REQ'D. HRS. 15

FIGURE 26

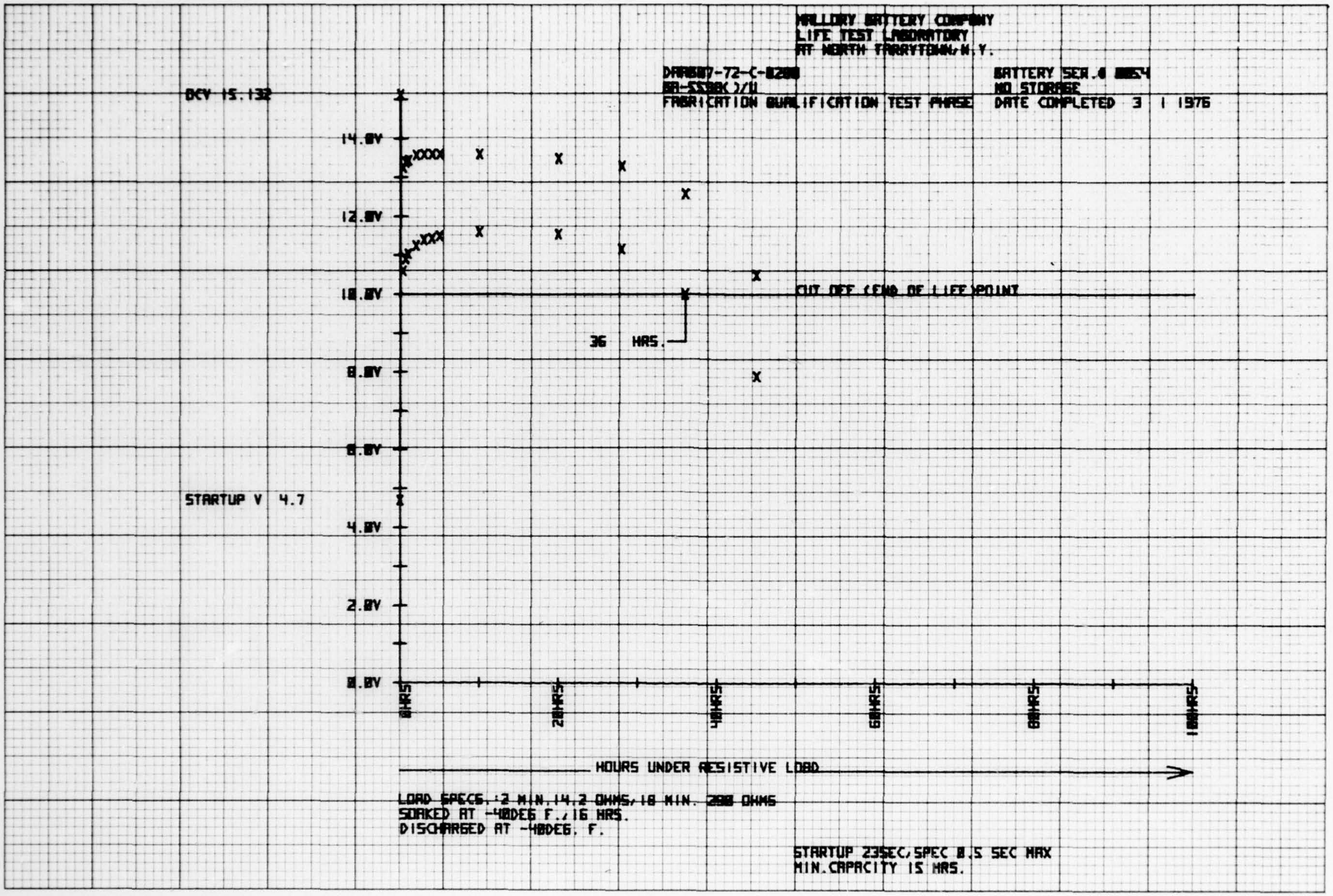

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0200
BA-5598( )/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER.# 0054
NO STORAGE
DATE COMPLETED 3 1 1976
OCV 15.132
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
CUT OFF (END OF LIFE)POINT
36 HRS.
STARTUP V 4.7
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.14.2 OHMS/18 MIN. 200 OHMS
SOAKED AT -40DEG F./16 HRS.
DISCHARGED AT -40DEG. F.
STARTUP 23SEC/SPEC 0.5 SEC MAX
MIN.CAPACITY 15 HRS.

FIGURE 27

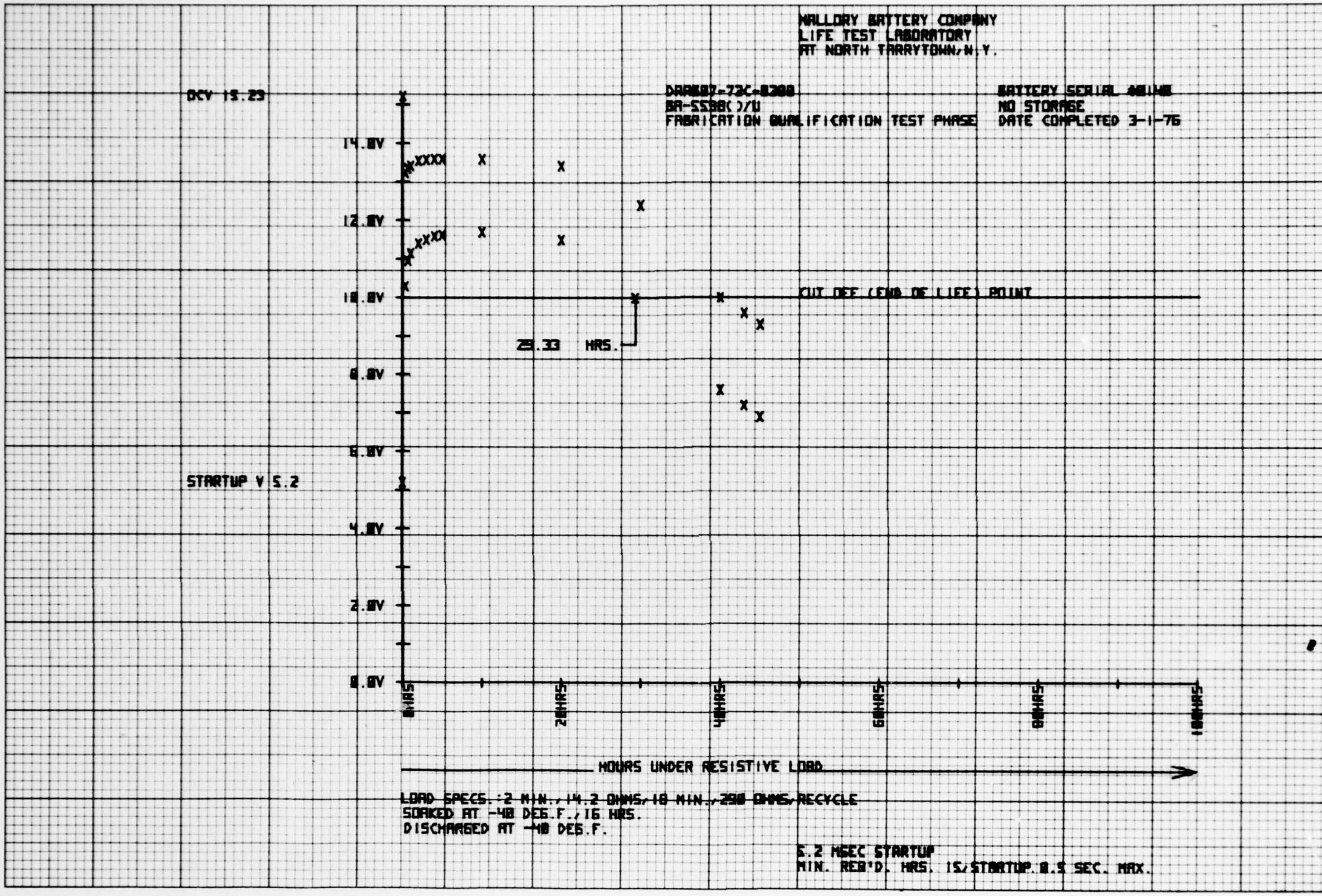

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-73C-0200
BA-5598( )/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SERIAL #0148
NO STORAGE
DATE COMPLETED 3-1-76
OCV 15.23
STARTUP V 5.2
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
CUT OFF (END OF LIFE) POINT
29.33 HRS.
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.,14.2 OHMS,10 MIN.,290 OHMS,RECYCLE
SOAKED AT -40 DEG.F.,16 HRS.
DISCHARGED AT -40 DEG.F.
5.2 MSEC STARTUP
MIN. REQ'D. HRS. 15/STARTUP 0.5 SEC. MAX.

FIGURE 28

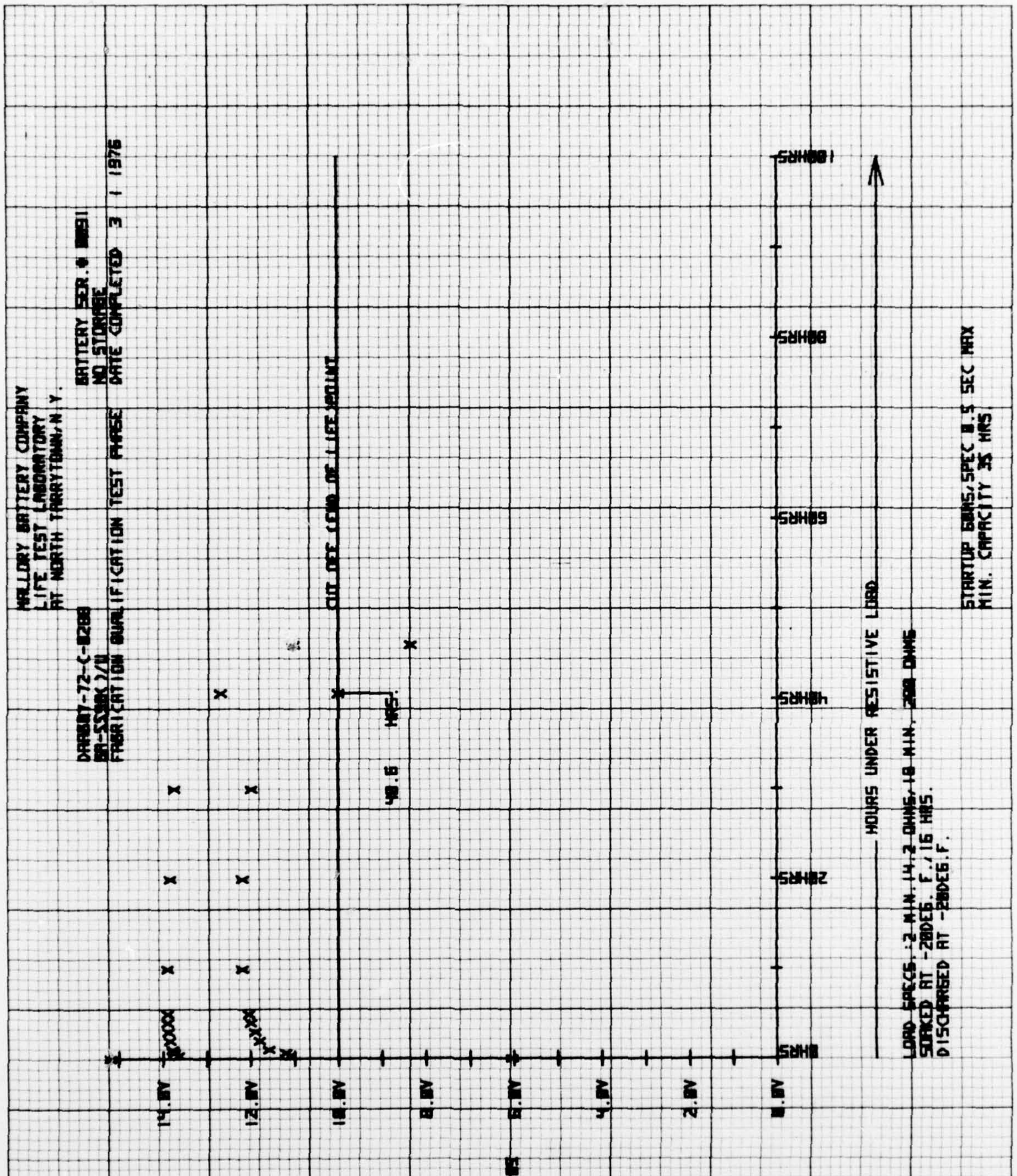

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
BATTERY SER.# 0091
NO STORAGE
DATE COMPLETED 3 1 1976
FABRICATION QUALIFICATION TEST PHASE
CUT OFF (END OF LIFE)POINT
48.6 HRS.
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.14.2 OHMS,18 MIN. 200 OHMS
SOAKED AT -20DEG. F./16 HRS.
DISCHARGED AT -20DEG.F.
STARTUP 60MS,SPEC 0.5 SEC MAX
MIN. CAPACITY 35 HRS.

FIGURE 29

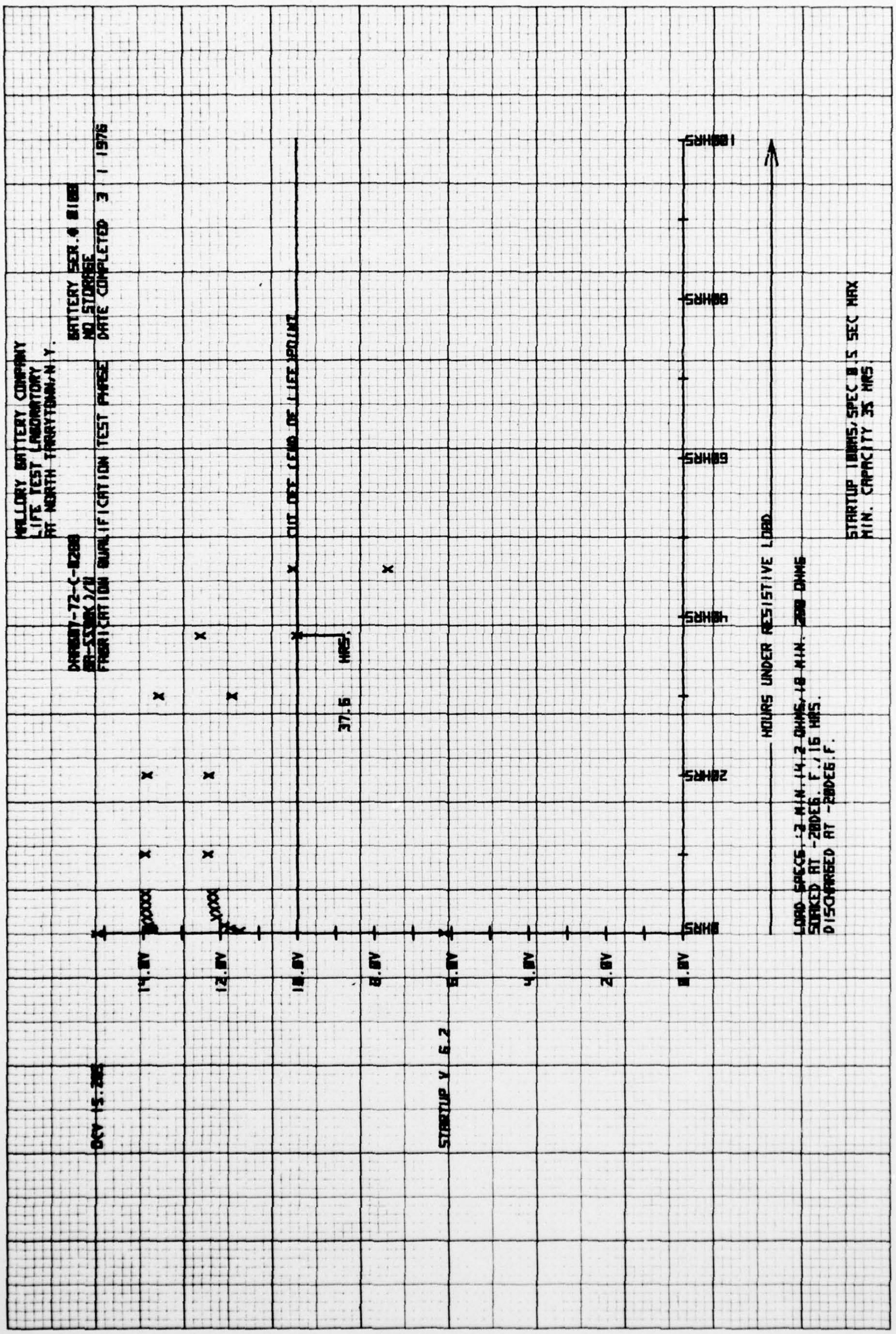

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN,N.Y.
FABRICATION QUALIFICATION TEST PHASE
NO STORAGE
DATE COMPLETED 3 1 1976
CUT OFF (END OF LIFE)POINT
37.6 HRS.
STARTUP V 6.2
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
SOAKED AT -20DEG. F./16 HRS.
DISCHARGED AT -20DEG.F.
MIN. CAPACITY 35 HRS.

FIGURE 30

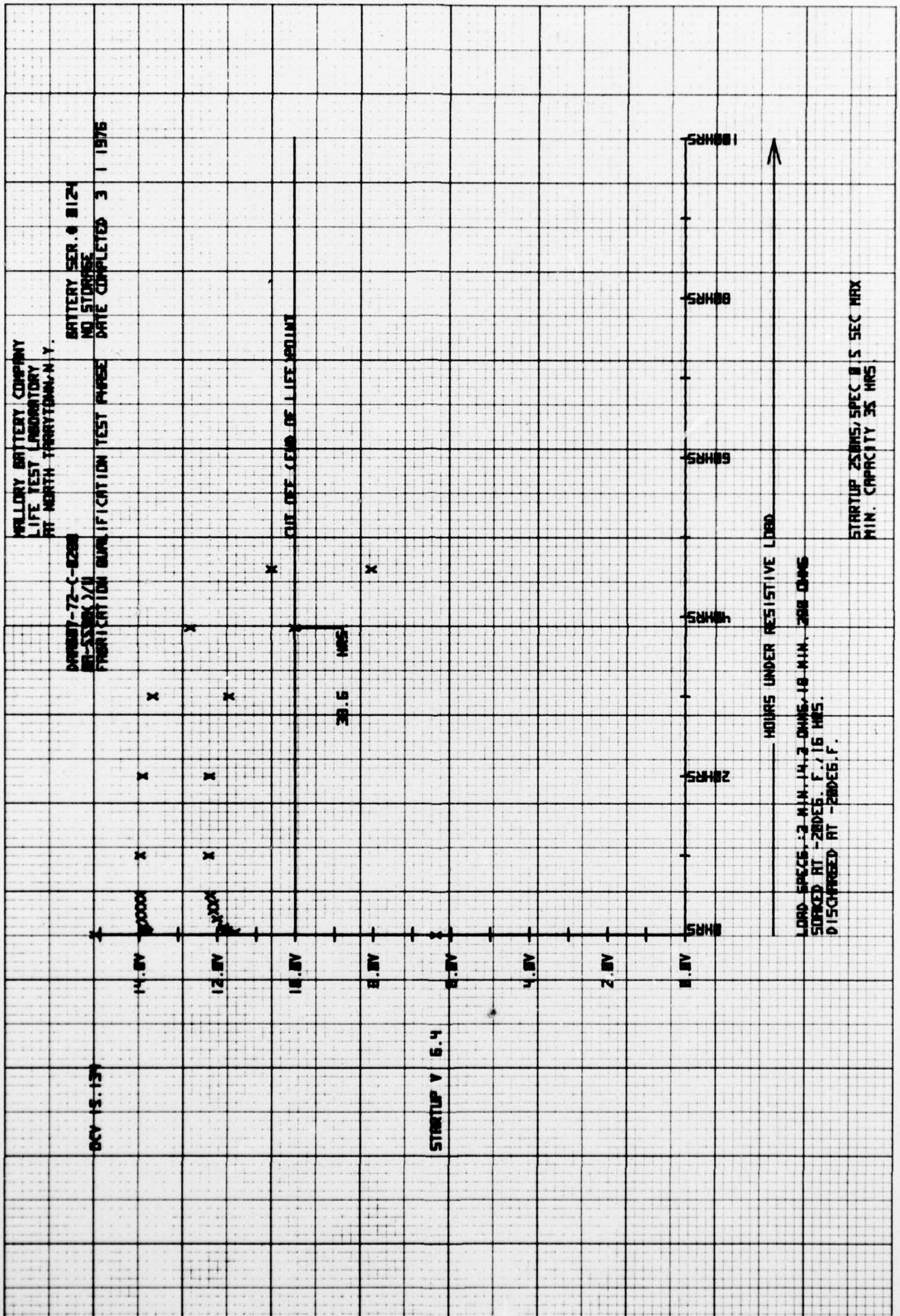

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72-C-0200
BA-5590( )/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER.# 0124
NO STORAGE
DATE COMPLETED 3 1 1976
OCV 15.13
STARTUP V 6.4
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
CUT OFF (END OF LIFE)POINT
30.6 HRS
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS.:2 MIN.14.2 OHMS/10 MIN. 200 OHMS
SOAKED AT -20DEG. F./16 HRS.
DISCHARGED AT -20DEG.F.
STARTUP 250MS/SPEC 0.5 SEC MAX
MIN. CAPACITY 35 HRS.

FIGURE 31

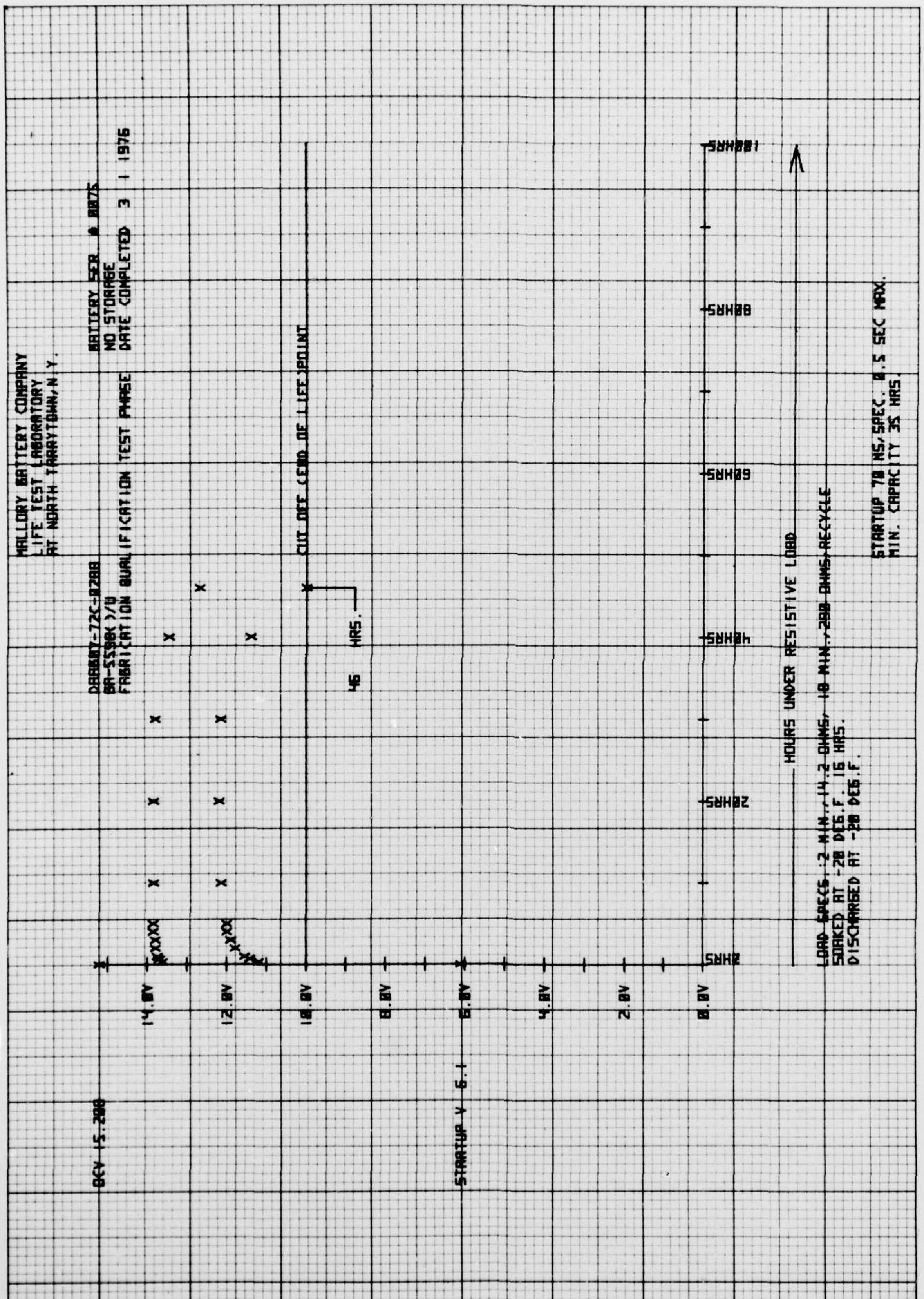

MALLORY BATTERY COMPANY
LIFE TEST LABORATORY
AT NORTH TARRYTOWN, N.Y.
DAAB07-72C-0288
BA-5598( )/U
FABRICATION QUALIFICATION TEST PHASE
BATTERY SER # 0075
NO STORAGE
DATE COMPLETED 3 1 1976
CUT OFF (END OF LIFE)POINT
46 HRS.
OCV 15.200
STARTUP V 6.1
14.0V
12.0V
10.0V
8.0V
6.0V
4.0V
2.0V
0.0V
0HRS
20HRS
40HRS
60HRS
80HRS
100HRS
HOURS UNDER RESISTIVE LOAD
LOAD SPECS :2 MIN., 14.2 OHMS, 10 MIN., 200 OHMS RECYCLE
SOAKED AT -20 DEG.F. 16 HRS.
DISCHARGED AT -20 DEG.F.
STARTUP 70 MS/SPEC. 0.5 SEC MAX.
MIN. CAPACITY 35 HRS.

FIGURE 32